Ecology—an integral part of fire management in cultural landscapes

A Keynote Address

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Fire, as a necessary ecological process, determines the nature and characteristics of many ecosystems. Fire also impacts some ecosystems very negatively. Broadly speaking, there are three classes of ecosystems that are determined by their overall response to fire events and fire regimes: 1) fire-dependent ecosystems--those that need a specific regime of fire and are characterized by plant species with adaptations to respond positively to fire and facilitate its spread, 2) fire-sensitive ecosystems--those that are negatively impacted by most fires; plant species are generally intolerant of fire, and 3) fire-independent ecosystems--those where fire normally plays little or no role.

Worldwide, over half of the ecosystems by area are fire-dependent, i.e. they need to burn, yet in many places scientific knowledge has yet to identify fire's role, and public policies and management strategies generally do not acknowledge the essential role of fire, leading to inappropriate management actions and programs that neither maintain desired ecosystems nor benefit biodiversity conservation. Coupled with the failure to recognize the beneficial role of fire in many ecosystems is a failure to identify the underlying socio-economic and cultural aspects of fire use in maintaining people's livelihoods, and how that burning may also be maintaining desired ecosystems. Novel approaches to dealing with fire-related problems involve integrating the technical aspects of fire management with appropriate ecological constraints and the socio-economic necessities of fire use. Forums and processes that promote an integrated approach to fire management that benefits both people and nature need to be developed and adapted to local and regional situations.

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Introduction

To be effectively engaged in wildland fire management, one has to be aware of the relationships between cultural landscape dynamics, wildland fire occurrence, and ecosystem responses. Even though protected area managers and conservationists like to think that they are preserving and protecting "natural ecosystems" that are maintained by natural processes, they all to often overlook, or do not understand, the fact that they are managing and protecting tiny remnants of natural systems imbedded in a much larger cultural landscape. Also, the "natural areas" themselves have had a long history of cultural intervention. There is a need to recognize and understand that how we deal with fire issues in natural areas has a lot to do with the cultural context in which they are imbedded.

An Example

A good example of the impact of cultural history on fire management in protected areas is on the island of Gran Canaria in the Canary Islands, which is an autonomous region of Spain located off the coast of southern Morocco.

The Canary Islands support a number of endemic species, not the least of which is the Canary Island pine, *Pinus canariensis*. This species is probably one of the most fire-adapted pines in the world. It has thick protective bark as an older individual, some populations have serotinous cones, it has the ability to resprout at the base when young trees are top killed, and it produces epicormic sprouts on the main stem after a crown fire in older stands (Fababú *et al.* 2007) See Figure 1.

Figure 1. Epicormic sprouting one year after a crown fire in a *Pinus canariensis* stand on Gran Canary Island. Such a response is an indicator of a history of high intensity fires. Photo by R. Myers

The technical team responsible for the restoration and maintenance of the Gran Canaria pine forests has:

1) identified fire as an important process in the evolutionary and ecological history of *Pinus canariensis* forests, i.e. these forests are tolerant of a wide range of fire intensities and frequencies as evidenced by the species' adaptations to fire;

2) recognized that these forests are mere remnants of what they may have been in the past, and that they are as much, if not more, a cultural artifact that has had a long history of changing land use, fire use, and reforestation, as they are a natural ecosystem;

3) recognized that free-ranging wildfires simply cannot be tolerated in the existing cultural landscape;

4) recognized that because of the present cultural context, the only way to effectively restore and maintain these forests is through prescribed burning that mimics the role that fire use to play in their ecological history; and

5) encountered some hurdles common to nascent prescribed fire programs—hurdles that are related to public perception and policy.

Barriers to effective fire management

What are some of the primary barriers and impediments that hinder effective wildland fire management no matter where one is in the world? These are

1) a lack of understanding of the ecological role of fire in ecosystems;

2) a failure to identify the underlying causes of fire problems and link them with appropriate solutions;

3) counter-productive public policies, legislation and perceptions.

Let's look at each of these in more detail.

1. Lack of understanding of the ecological role of fire in ecosystems

First, there is frequently a failure to understand and distinguish broad categories of ***vegetation response to fire***, e.g. fire-dependent ecosystems, fire-sensitive ecosystems, and fire-independent ecosystems. Fire-dependent ecosystems require an ecologically appropriate fire regime and species have adaptations to this regime. Fire-sensitive ecosystems are those where fire of any type is usually detrimental because the species lack adaptations to respond positively to it. Biodiversity in these ecosystems, however, may depend on some fire disturbances. Fire-independent ecosystems are simply too cold, too wet or too dry to burn. They lack fuels, or fuels are usually not available, to burn.

The Nature Conservancy, through the Global Fire Partnership, has made one of the first attempts to look at fire globally as a conservation and biodiversity issue (Hardesty *et al.* 2005; Shlisky *et al.* 2007) by classifying major habitat types and ecoregions according to their predominant response to fire. At this scale, at least ½ of the world's terrestrial ecosystems depend on fire to maintain their character and biodiversity, yet this fact goes largely unrecognized by scientific and technical experts in many parts of the world.

Second, there is a failure to understand ***fire regimes*** and to determine what sort of fire regime is ecologically appropriate for a given ecosystem.

What is a fire regime? It is a set of recurring conditions of fire that characterize a given ecosystem. For a give site, it may be a unique fire history. Virtually all ecosystems have a fire regime, even those that are fire-sensitive, i.e. there is a certain level of burning that takes place in any ecosystem that contributes to its underlying character. Without that level of burning, the ecosystem would loose that character; species would be lost.

What are these conditions or components of a fire regime? They are ***Fire type***, i.e. ground, surface or crowning fires; ***Fire frequency***, i.e. how often on average fire returns to a given location; ***Fire behavior***, i.e. intensity and rate of spread; ***Burn severity***, i.e. fire's impact on the biota and soils; ***Timing***, i.e. season of burn or burning in relation to meteorological or phenological events; and ***Size and pattern of burn in the landscape.***

Variation in each fire regime component may be more important ecologically than its average property. Managing fire through prescribed burning, or through suppression activities and prevention campaigns, may lead to less variation and unexpected ecosystem and biodiversity changes. Changing one fire regime component invariably affects others, e.g. increase the time between fires and intensity is likely to increase due to increased fuel loads.

How well do we understand fire regimes? This question is best answered by a quote from Whelan (1995): *We don't have much information about the effects of a variety of fire regimes. Instead we have a set of cautionary tales about the potential damage that might result from a fire regime that includes fires that are too frequent, too small, or too cool.*

Understanding fire regimes requires long term studies that can either reconstruct fire history using dendrochronological or palynological techniques or permanent plots that monitor vegetation through several burn cycles. The former are limited by local geographical conditions; few researchers have the wherewithal to do the latter, and most field studies focus on the effects of individual burns.

Third, there is a failure to recognize the ***role of human burning*** in maintaining desired ecosystem states. Human intervention in fire regimes is really not at question. On any landscape we are looking at the results of a historic fire regime, not a "natural" fire regime. Where people have lived in fire prone vegetation, they have burned it for long time, they have burned it for a variety of reasons, and they have burned it a lot. In academic discussions of fire, there is a tendency to distinguish between human-ignited fires and naturally-ignited fires, with the latter somehow being better than the former. This distinction, however, is of little practical value. A more important issue is what is the conservation value of a given ecosystem state and what is the fire regime that maintains it? The ignition source of the fires is not important. Other key questions related to anthropogenic fires are: what role, if any, do human-ignited fires play in maintaining desired ecosystem states or conservation targets? And, how can human-ignited fires be manipulated to meet conservation and management goals?

Fourthly, there is a failure to understand the link or ***relationships between fire-dependent ecosystems and fire-sensitive ecosystems***, or between adjacent ecosystems maintained by different fire regimes. Fire regimes are frequently mediated by the characteristics of the vegetation and the fuels they produce—this leads to discrete vegetation patterns in the landscape and transition zones or ecotones that may be uniquely important for biodiversity. The existence of several types of ecosystems within a protected area may require different approaches to fire management in each type, and consideration must be given to the management and maintenance of transition zones.

2. Failure to link the underlying causes of fire problems with appropriate solutions

Most fires are ignited by people for the purpose of maintaining their livelihoods. This is a fact in many parts of the world. Amongst those people responsible for fire management, there is frequently a failure to understand the socio-economic context in which many fires occur. Instead, there is a focus on emergency response to individual fire events rather than on the underlying causes of repeated fire problems which would call for focusing on long-term solutions. Prevention programs are likely to label all fires as bad even though the target audience of the campaign may need to use fire.

3. Counter-productive public policies and legislation

Policies and funding tend to be directed toward fire suppression and fire prevention even in those ecosystems that need to burn. True, unconstrained wildfires usually cannot be tolerated even in these ecosystems, but no latitude is given to the manager to use wildfires when they occur to meet specific management objectives, and few option are open for the use of prescribed fire or controlled burns. Many countries prohibit the use of prescribed burning in national parks and protected natural areas because the management intervention is not “natural”, yet they fully embrace the suppression of fires in these same parks—which is also an “unnatural” management intervention.

Furthermore, in many countries fire use is criminalized. This leads rural agriculturists and pastoralist to ignite fires anyway, but not to tend them, so they cannot be held responsible for any damages that the fires might cause. This exacerbates rather than alleviates the problem of wildfire ignitions and it prevents agencies and NGO’s from developing programs to teach farmers how to keep their fires under control, because they would, in a sense, be teaching farmers how to safely conduct an illegal act. In other areas where burning is allowed through a permit process, that process is frequently too cumbersome to allow farmers to take advantage of favorable conditions for burning, so they burn without authorization.

An integrated framework for addressing fire problems

Fire management can be considered all of the ***technical*** decisions, strategies and actions directed toward fire problems and issues. Those technical aspects can be illustrated as a “fire management triangle” with the three sides being fire prevention, fire suppression, and fire use. Many parts of the world have sophisticated prevention and suppression programs, yet their fire problems

continue to mount. The side of the triangle that is frequently missing or poorly developed is all of the technical approaches to fire use, i.e. prescribed fire, controlled agricultural and silvicultural burns, and wildland fire use decisions (Figure 2).

Figure 2. The Fire Management Triangle shows the three technical components that make up effective fire management. From Myers (2006).

Integrated fire management can also be illustrated with a triangle (Figure 3), where one side is all of the technical aspects of Fire Management; the other two sides are Fire Ecology and Fire Culture, i.e. the socio-economic necessities of using fire. Integrated fire management assumes that fire problems cannot be addressed effectively solely by utilizing and modernizing the technical aspects of fire management, but rather fire management decisions have be made with an understanding of the fire ecology of the affected ecosystems and the culture and necessities of the people living in those ecosystems. In ecosystems where the benefits of fire outweigh potential damages, strategies that foster effective fire use will predominate. In ecosystems where the majority of fires are detrimental, prevention and suppression strategies should be dominant (Figure 4). In either case, however, both fire use strategies and prevention/suppression strategies are needed to varying degrees.

Figure 3. Integrated fire management triangle illustrates that fire management decisions need to be coupled with knowledge about fire ecology and the fire culture. From Myers (2006).

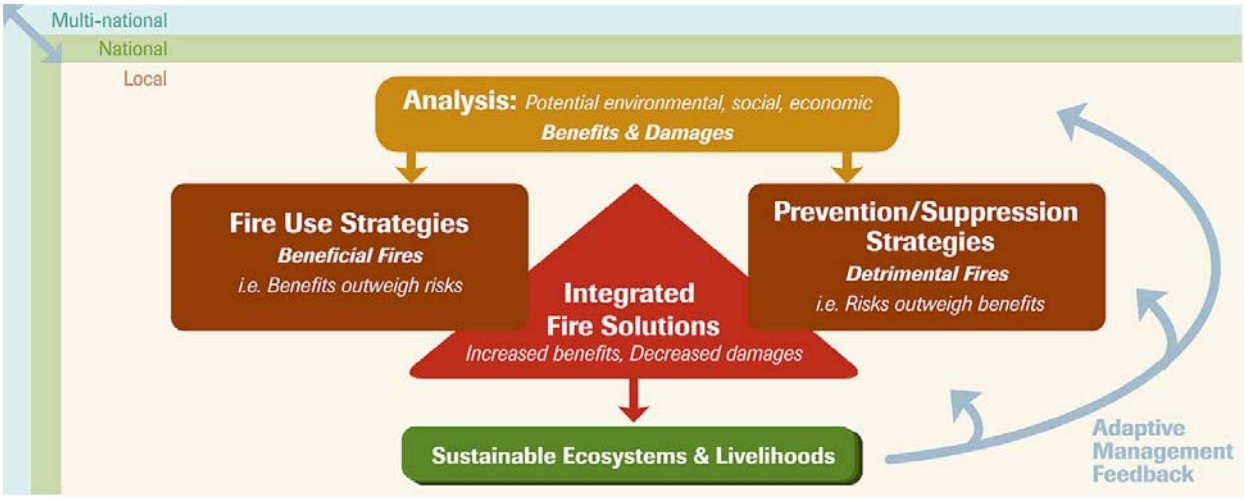

Figure 4. The goal of integrated fire management is sustainable ecosystems and livelihoods. Fire management decisions have to incorporate both the fire ecology and fire culture of the area under consideration and determine the relative importance of fire use and prevention suppression strategies. From Myers (2006).

Synopsis

There are discrete steps to consider in the design and implementation of ecologically appropriate fire regimes in landscapes of remnant native vegetation. They are:

1) Remember that fire is not the end product. We do not have forest reserves and protected natural areas so we can burn them or so we can keep them from burning. We have conservation areas because they contain something of conservation value that we want to protect and maintain. Those conservation targets may require fire or may be sensitive to fire or two certain types of fire. Those requirements and sensitivities must be understood.

2) Because conservation targets have specific fire management needs, we need to set fire management goals and objectives related to those targets.

3) Establish fire management objectives by identifying the "critical elements" of conservation, i.e. what are the key objects of conservation or management and how are they impacted or affected by fire? Those objects may be rare species, specific habitats, or a landscape mosaic of vegetation and habitat types.

4) Base goals and objectives on both knowledge and *inferences* about the life histories and dynamics of the dominant species that control the fire regime, and priority species and ecosystems. The use of inferences implies that we must make management decisions with incomplete knowledge. We cannot wait until everything is known about priority species and ecosystems.

5) Use historical information as a reference to gain insight into the origin of current ecosystem states and to understand ecosystem potential, but not necessarily to recreate a historical ecosystem state. The landscape must be considered in terms of past and current cultural conditions and influences.

6) Because we never have complete information, use conceptual fire regime models as guides to appropriate fire management.

7) Because management actions are based on inferences more than on complete knowledge, these actions must be monitored.

8) It is feedback from these monitored trends that drive future management actions=***adaptive management.***

9) Expect to make compromises because of safety and liability concerns, and due to capacity constraints, i.e. it may not be possible to implement the desired fire regime. The use of fire surrogates may have to be used in some situations.

10) Resources should be directed towards solutions focusing on the underlying causes of fire problems and not solely on expensive tools and technologies that do nothing to address those underlying causes. Programs that teach farmers how to keep agricultural fires under

control are far less expensive that purchasing, maintaining, and operating a single aerial tanker or helicopter.

11) Fire management goals will not be reached without considering the needs and issues of local communities, gaining their support, and working with them to meet those needs.

12) Understand the cultural uses of fire, the necessity of using fire, and the potential positive and negative impacts of fire use on fire management goals and on the landscape.

13) Where appropriate, promote the concept of the "Two Faces of Fire" i.e. "Good Fire" and "Bad Fire", instead of messages of fire prevention. Good Fires are those agricultural fires that remain under control and meet the needs of farmers and rural communities. Good Fires are those that are burning as part of a predetermined appropriate fire regime and do not threaten people and property. Bad Fires are any fires that are out of control and have the potential to negatively impact people, their property, and conservation targets.

Literature Cited

Fababú, D. D., F. Grillo, D. García-Marco & D. M. Molina-Terrén. 2007. Caracterización de las quemas prescritas en Gran Canaria: valoración de 5 años de experiencia. IV International Wildland Fire Conference. Sevilla, Spain.

Hardesty, J., R. L. Myers, W. Fulks. 2005. Fire, ecosystems, and people: a preliminary assessment of fire as a global conservation issue. *The George Wright Forum* 22:78-87.

Myers, R. L. 2006. Living with fire: sustaining ecosystems and livelihoods through integrated fire management. The Nature Conservancy, Arlington, VA, USA.
http://www.tncfire.org/documents/Integrated_Fire_Management_Myers_2006.pdf
http://www.tncfire.org/documents/el_manejo_integral_del_fuego.pdf

Shlisky, A. J. Waugh, P. Gonzalez, M. Manta, H. Santoso, E. Alvarado, A. Ainuddin Nuruddin, D. A. Rodríguez-Trejo, R. Swaty, D. Schmidt, M. Kaufmann, R. Myers, A. Alencar, F. Kearns, D. Johnson, J. Smith, D. Zollner & W. Fulks. 2007. Fire, Ecosystems and People: Threats and Strategies for Global Biodiversity Conservation. GFI Technical Report 2007-2. The Nature Conservancy, Arlington, VA, USA. http://www.tncfire.org/documents/fire_ecosystems_and_people.pdf

Whelan, R. J. 1995. The Ecology of Fire. Cambridge University Presses, UK.