The Contribution of Natural Fire Management to Wilderness Fire Science

BY CAROL MILLER

Abstract: When the federal agencies established policies in the late 1960s and early 1970s to allow the use of natural fires in wilderness, they launched a natural fire management experiment in a handful of wilderness areas. As a result, wildland fire has played more of its natural role in wilderness than anywhere else. Much of what we understand about fire ecology comes from observations of natural fires in several wilderness areas that have been allowed to burn under a wide range of physical and biological conditions since the 1970s. Wilderness fires have provided valuable datasets for improving fire history methods and understanding of the drivers of fire. Inside some wilderness areas, enough data have accumulated from multiple repeated fires at natural fire intervals to see how forests respond to fire. As a result of the wilderness fire management experiment we can better anticipate the consequences of reintroducing fire and whether restoration with natural fire might be feasible. The experience of allowing fires to burn in wilderness has also contributed to social science knowledge. Studies have examined how public support for the use of fire in wilderness can change over time. Studies of the institutional factors that influence the use of fire in wilderness have pointed to difficulties with implementing wilderness fire policy, as well as the importance of belief and commitment of an individual line officer in overcoming obstacles to carry out a wilderness fire program. Future trends in climate and land use will exacerbate current challenges for wilderness fire management programs, and making the decision to allow fire to burn in wilderness will increasingly demand scientific information and will likely require an even more firm belief in the value of natural fire.

Introduction

Wilderness holds unique scientific value as a reference or benchmark for change. By examining wilderness, fire researchers have been able to study the role of fire on ecosystems without being confounded by effects of human activities and other disturbances such as logging. Not surprisingly, several compilations and summaries of wilderness fire science can be found in the literature (Lotan et al. 1985; Kilgore 1986; Brown et al. 1995; Agee 2000). In pointing out specific areas where progress in wilderness fire science has been limited, the most recent state-of-knowledge review (Agee 2000) highlighted a lack of data and insufficient sophistication of computer models to incorporate complexity. The review also concluded that the best way to learn and advance wilderness fire science is for managers to assume the risk of allowing fires to burn.

A rich history surrounds the natural experiment of allowing fires to burn in wilderness (van Wagtendonk 2007). Drawing from the Leopold Report of 1963 and the Wilderness Act of 1964, both of which recognized the role of natural disturbance processes in shaping primitive wilderness landscapes, the federal agencies established policies in the late 1960s and early 1970s to allow the use of natural fires in wilderness. The earliest wilderness fire programs in the National Park Service began at Sequoia and Kings Canyon National Parks (NPs) (1968), Yosemite NP (1970), Saguaro National Monument (1971), and Yellowstone NP (1972). In the Forest Service, the Selway-Bitterroot

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Wilderness launched the Forest Service's wilderness fire program (1972). Slowly, several other parks and wilderness areas adopted the practice of allowing some natural ignitions to burn with limited or no interference (e.g., Gila Wilderness in 1975, Bob Marshall Wilderness in 1981, and Glacier National Park in 1994). By allowing fires to burn in wilderness on their own terms, wilderness managers launched a large-scale experiment that would greatly advance our scientific understanding of fire.

Wildland fire has played its natural role more in wilderness than anywhere else because this experiment has primarily played out in designated wilderness and in protected areas that are managed similar to wilderness (e.g., Grand Canyon National Park). The experiment has not been easy to carry out and suppression of fire remains the dominant management strategy in most wilderness areas (Parsons 2000). However, the practice of allowing fires to burn has been successfully adopted in a handful of case study areas. The experiment has yielded observations of fire and fire effects in diverse conditions that have resulted in new ecological knowledge. The experiment has also evoked and effected social responses that have added to our social science knowledge. In this article, I highlight some of these contributions to knowledge that have been made in both the ecological and social sciences, and speculate about future progress in wilderness fire science.

50 Years of Contributions to Fire Science

Much of what we understand about fire ecology – the study of fire effects, natural vegetation dynamics, and succession – is derived from observations of natural fires in wilderness. Wilderness fires have been allowed to burn under a wide range of physical and biological conditions in several wilderness areas since the 1970s. As a result, we've been able to study the causes and consequences of fires and test assumptions about effects of repeated fires on ecosystems. Fires burn outside wilderness areas, of course, but it is inside wilderness where enough data have accumulated from multiple repeated fires at natural fire intervals. For one example, DeLuca and Sala (2006) studied wilderness areas in the northern Rockies, comparing frequently and naturally burned sites with sites that had not burned in recent history. In doing so, they were able to corroborate long-standing but previously untested hypotheses about soil nitrogen dynamics in fire-dependent ponderosa pine ecosystems. Another study that relied on the unmanaged qualities of wilderness was able to quantify the retention of fire-created snags over time and through repeated fires in the Gila Wilderness in New Mexico (Holden et al. 2006). This research was possible only because fire-created snags are not salvaged for their wood in wilderness and because fires had been allowed to burn repeatedly under a fire management program aimed at restoring natural fire regimes. Similarly, this same fire management program allowed Holden et al. (2009) to focus on environmental controls of burn severity for fires that burned within the natural season and whose behavior was largely unaffected by roads and suppression or previous logging or grazing activities.

The wilderness fire management experiment has allowed us to better anticipate the consequences of reintroducing fire and whether restoration with natural fire might be feasible. Studies have shown that long fire-free intervals can alter forest structure, but they have also shown that large trees can be quite resistant to fires when they do occur (Holden et al. 2007; Leirfallom and Keane 2011). Furthermore, fires that burn severely and kill trees can serve to restore forest structure (Fulé and Laughlin 2007). A study of ponderosa pine forests in the Bob Marshall Wilderness in Montana recently showed that some unlogged, fire-excluded forests in wilderness possess a latent resilience to reintroduced fires and suggested that in some cases, a prescription for restoration is simply to allow lightning-ignited fires to burn (Larson et al. 2013).

Restoration is guided by information about the historic range of variation of ecological conditions and disturbance regimes. Fire history studies are especially important for providing the data and the context for understanding the historic range of variation, but certain data collection methods have been viewed critically because of their inferential nature (Baker and Ehle 2001). Wilderness studies, and the natural experiment of the wilderness fire management program, have been able to address some of these concerns about the quality of inferences that can be made with fire scar sampling. Because maps of fires that have burned during this experiment do exist, they can be compared against the fire scar record, and the uncertainty associated with point-based fire scars can be quantified (Farris et al. 2010; Farris et al. 2013).

Wilderness fires have provided valuable datasets for the study of landscape ecology, a field of study concerned with the causes and consequences of spatial patterning in ecosystems. Large landscape-scale fire history studies in wilderness have increased our understanding of the drivers of fire regimes (Rollins et al. 2002; Haire et al. 2013; Morgan et al. 2014), and the natural fire management experiment in wilderness has provided empirical support for landscape ecological theory. For example, ecological theory posits that freely burning fires over large landscapes will engage in a self-regulating feedback between the spatial pattern of vegetation and the process of fire (McKenzie et al. 2011). Indeed, empirical studies of wilderness fires in the Sierra Nevada, northern Rockies, and Southwest are showing that burned areas left by wildfires generally limit the spread of subsequent fires and moderate the severity of subsequent fires (Collins et al. 2009; Holden et al. 2010; Teske et al. 2012; van Wagtendonk et al. 2012; Parks et al. 2014). None of this research would be possible without the legacy of a landscape mosaic created by the wilderness fire programs in these wilderness areas (see Figure 1).

Figure 1 – Landscape mosaic in the Selway-Bitterroot Wilderness created by a sequence of freely burning fires since the 1970s. Photo by Carol Miller.

Notable contributions have also been made to the social sciences as a result of managing wilderness fire. Although fire-related social science research has encompassed a gamut of subjects, including risk perception, community preparedness, community-agency relationships, and acceptance of smoke, most research has been focused on perceptions, attitudes, and behaviors of homeowners living in the wildland-urban interface (McCaffrey et al. 2013). Only a scant few studies have specifically addressed naturally burning fires in wilderness; these have examined either external or internal factors interacting with wilderness fire management.

As public support potentially imposes an external constraint on wilderness fire management, a handful of studies have examined how the public views wilderness fire. Early surveys of wilderness visitors suggested that support for the idea of allowing natural fires to burn in wilderness was related to one's level of knowledge of fire (Stankey 1976; McCool and Stankey 1986). Later surveys of wilderness visitors often included questions about wilderness fire management (Borrie et al. 2006; Knotek et al. 2008) and a synthesis of such results showed a general trend of increasing support for the use of fire in wilderness (Knotek 2006). Surveys have also revealed the tension between the public's support for wilderness fire and community protection concerns (Winter 2003; Kneeshaw et al. 2004).

Factors internal to the federal agencies can also be important constraints to wilderness fire management (Steelman and McCaffrey 2011). Decisions to allow fires to burn are subject to much higher levels of scrutiny than decisions to suppress, and a few studies have examined institutional factors that influence the use of fire in wilderness (Williamson 2007; Doane et al. 2006; Black et al. 2008). One study found that line officers who perceive there is value in the benefits of fire are more likely to authorize its use in wilderness (Williamson 2007; Black et al. 2008). Although these managers faced many obstacles to allowing wilderness fires to burn, it appeared that a belief and commitment impelled them to overcome those barriers. In other words, the success of a wilderness fire program may hinge on an individual.

The Next 50 Years

The managers who launched the wilderness fire management experiment nearly 50 years ago probably did not anticipate the rapid and dramatic environmental changes that have since occurred. Today, developments in science and technology allow us to better anticipate the future. Both climate variability and surrounding land use will affect wilderness fire regimes and their management in the next several decades (IPCC 2007; Theobald and Romme 2007) with important implications for policy (Dombeck et al. 2004). Successful protection and stewardship of wilderness means anticipating how a changing climate along with a changing human footprint will affect fire regimes in the future (Miller et al. 2011).

Predicted changes in climate will affect various aspects of wilderness fire regimes, including the seasonality, frequency, extent, spatial pattern, and severity of fires (McKenzie et al. 2004; Fried et al. 2008). What was considered extreme fire danger in the past will become more the norm by the middle of the 21st century (Miller et al. 2011). Prescriptive windows that currently provide opportunities for allowing wilderness fires to burn could become quite narrow in the near future. This situation will be exacerbated by land use changes and development patterns. In particular, housing density near wilderness areas is projected to increase (Radeloff et al. 2010), elevating the potential fire risk to homeowners and the pressure to suppress wilderness fires (Miller and Landres 2004). As more people choose to live closer to wilderness areas (see Figure 2), the complexity of managing natural fire regimes in wilderness will increase (USDA and USDI 1998), likely decreasing the opportunities for allowing wilderness fires to burn on their own terms. As time goes on, the feasibility of allowing wilderness fires to burn unimpeded may decline or vanish altogether, particularly in smaller wilderness areas that simply are not big enough for long-duration fires to spread naturally without threatening adjacent values-at-risk (Husari 1995).

For wilderness fire management programs to continue, managers will need tools that can identify those windows, however narrow, within which natural wilderness fire is a viable option. Nationally, fire management has adopted risk analysis as a decision-support framework, and several wildfire risk analysis tools are available for quantifying potential loss due to fire (Miller and Ager 2013). To support fire management decisions in wilderness, these tools may need to be adapted and applied in new ways (Barnett, unpublished).

The projected trends in climate and housing density only heighten the scientific value of wilderness and the value of the wilderness fire management experiment. For example, those areas where natural fires have been allowed to burn are a unique laboratory for studying ecological resilience in a changing climate. As these landscapes respond to increased fire activity, they provide the opportunity to see and learn how resilient landscapes are best created and maintained. Importantly, limits to this resilience may be discovered as the climate changes, allowing ecological thresholds that lead to irreversible change (e.g., vegetation type conversion) to be better understood and anticipated.

Could these trends threaten the continuation of wilderness fire programs? An increasingly complex environment demands more and better information to support wilderness fire management decisions that are being made in an increasingly constrained decision space. Fortunately, research can take advantage of the experiment launched nearly 50 years ago to provide some of this information. The continuation of the wilderness fire program will also depend more strongly on individual managers. The pioneering managers who initiated the wilderness fire management experiment did so by assuming risks and facing uncertainties. These were managers who, as Williamson (2007) found, worked through myriad challenges and barriers (Doane et al. 2006) because they were anchored by a belief in the value of fire. Their successors likely will have a more difficult job in the future, and making the decision to allow fire to burn in wilderness may require an even more firm belief.

Conclusion

The best way to learn about fire is to observe fires burning in the natural environment under a diversity of conditions and then to observe and

Figure 2 – Residential housing close to wilderness increases the complexity of managing wilderness fires. Photo by Carol Miller.

The wilderness fires that have been allowed to burn over the past 50 years have provided a valuable long-term dataset for describing the beneficial effects of wilderness fire and its role in creating and maintaining resilient landscapes.

evaluate their effects over time. The wilderness fires that have been allowed to burn over the past 50 years have provided a valuable long-term dataset for describing the beneficial effects of wilderness fire and its role in creating and maintaining resilient landscapes. The ecological research conducted as a result of the wilderness fire program has been especially fruitful and has advanced the scientific fields of both fire ecology and landscape ecology. Fire-related social science research has paid far less attention to naturally burning fires in wilderness, although a few targeted studies have yielded relevant and applicable results for wilderness. The past 50 years have shown that the decision to allow a fire to burn has always been a difficult one to make. As environmental and social trends complicate the context for wilderness fire management over the next 50 years, this decision will only get more difficult. The future of wilderness fire management programs may now depend on adding to the existing knowledge with research, as well as an unwavering commitment by individuals to managing this keystone natural process.

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