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Editorial

Introduction to the effects of wildland fire on aquatic ecosystems in the Western USA

The management of wildfire has long been controversial. The role of fire and fire-related management in terrestrial and aquatic ecosystems has become an important focus in recent years, but the general debate is not new. In his recent book, Stephen Pyne (2001) describes the political and scientific debate surrounding the creation of the U.S. Forest Service and the emergence of fire suppression as a central tenet of wildland management. Essentially, views in the first decade of the 20th century focused on fire as good or evil: a tool that might benefit other resources or interests (e.g. Indian burning) and mitigate larger more destructive fires, or a threat to the recruitment and productivity of newly designated forest reserves. The ''great fires'' in the Western USA in 1910 and the associated loss of human life and property largely forged the public and political will to suppress fire on a massive scale.

In some forest types the fallacy of a management policy based on fire suppression at any cost has become obvious during recent decades. Fire suppression, coupled with selective silvicultural practices, livestock grazing, and other human disruptions, including climate change and an ever expanding urban–wildland interface, has led to the possibility of larger, more destructive fires, reminiscent of those in 1910. Large fires in the last two decades have again generated a public and political desire to respond. The National Fire Plan (U.S. Department of Agriculture, 2000) and linked initiatives outline a comprehensive strategy intended to protect communities, reduce fuel loads and the threat of large fires, and restore damaged ecosystems. The USA Congress has responded with significant funding and the President of the USA has proposed to constrain the environmental regulatory and review process that slowed the implementation of new management initiatives (see the President's Healthy Forest Initiative available online: http://www.whitehouse.gov/infocus/healthyforests/Healthy_Forests_v2.pdf).

Despite these actions, the debate continues. As Pyne (2001) points out, there is no simple dichotomy of fire suppression versus the use of fire, or one of fuels treatments versus acceptance of the fires that may follow without them. These oversimplified perspectives are complicated by social and ecological trade-offs that we are just beginning to understand based on our nearly century-old experiment in fire suppression. Among them are that fire and the effects of fire are important ecosystem processes, which fire management will also influence. Also, fires are not driven by fuels alone, but also by climate, and climate is changing. And large fires are natural; we cannot eliminate them—as recent events throughout the Western USA have illustrated—and it might be ill-advised even if we could. Thus, management to ensure that natural systems are resilient to or even benefit from large fires could be important.

The management of fire is particularly relevant to the aquatic ecosystems of the Western USA. More than a century of human development has produced a legacy of habitat degradation, fragmentation, and loss, and an expansion of nonnative species across the lakes, rivers, and streams of the region. The result has been the accelerated extinction of species and stocks and increased listings of them under the Endangered Species Act and of impaired waters under the Clean Water Act. Because past land management is perceived as a primary cause of the disruption of aquatic ecosystems, new proposals for aggressive management of forest vegetation and fuels to mitigate the

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increasing risks of severe fire have been viewed with skepticism and concern. There is little evidence to suggest, for example, that we have solved the problems of sustainable management for multiple natural resource objectives (Ludwig et al., 1993). One compelling reason to move forward may be that fire can also have dramatic effects on the organisms, habitats, and watersheds we hope to conserve. Large fires might be particularly destructive for already degraded aquatic systems. And thus the apparent dilemma: which is worse, new fires that may result from past management, or new management intended to mitigate those fires?

In practice, protection of aquatic species and habitats has largely been an exercise in identifying the remnant populations and high quality or productive habitats and protecting them from further human disruption (Bisson, 1995). In some cases such efforts might include the manipulation of habitats for select life stages. In essence the goal has been to conserve or create suitable conditions for select species wherever we can. A system of conservation reserves where human influences are minimized is undoubtedly a critical element in the struggle to conserve native aquatic biological diversity (Bisson, 1995; Reeves et al., 1995). Some argue, however, that conservation reserves will likely never contain the full range of biological diversity we hope to maintain in managed landscapes (Franklin, 1993; Seymour and Hunter, 1999), in part because unless they are very large these reserves are vulnerable to natural disturbances such as wildfire or large storms (Reeves et al., 1995; Kruse et al., 2001; Harig and Fausch, 2002).

The concept of natural systems as dynamic is not new to evolutionary biologists, forest ecologists interested in community succession, or geomorphologists interested in the evolution of landforms and stream channels, but the notion that disturbance might be critical to maintaining resilient, productive aquatic communities (e.g. Poff and Ward, 1990; Reeves et al., 1995; Frissell et al., 1997) has added a new dimension to the debate over land management in recent years. Pondering whether a new fire, or management intended to mitigate that fire, poses the greatest threat to the short-term persistence of a threatened population misses the point. Rather, we must carefully consider the implications of either course for the maintenance and restoration of the processes that structure landscapes, communities, and the evolutionary potential of the populations embedded therein. Some have argued that managed disturbance, either to emulate or to restore the role of fire and other disturbance-related processes, could be key to sustaining landscapes over the longer term (Reeves et al., 1995; Poff et al., 1997; Cissel et al., 1999; Naiman et al., 2000).

Independent of fire, the history of management of terrestrial and aquatic ecosystems can be seen as one of conflict. Conservation of aquatic biological diversity and productive fisheries, for example, has generally been viewed as a constraint on the options available to forest managers. As noted earlier, forest management activities have generally been viewed as harmful to aquatic systems. This conflict has often been resolved through regulatory processes that sometimes invite political as well as ecological solutions (e.g. The President's Healthy Forest Initiative). Yet the concept of ''ecosystem management'' (Ecological Society of America, 1995), which agencies like the U.S. Forest Service have attempted to embrace, emphasizes that terrestrial and aquatic ecosystem management are elements of the same problem: one of managing human disturbance and whole landscapes to maintain self-organizing ecosystems, and of restoring ecological processes and the critical linkages between terrestrial and aquatic systems that contribute to the resilience of both (Bisson, 1995; Allen et al., 2002). Hence there should be more common ground and more integrated solutions.

The workshop on the Effects of Wildland Fire on Aquatic Ecosystems in the Western USA was convened in Boise, Idaho, USA in April 2002 to synthesize the emerging science and discussion relevant to such solutions. The organizing committee invited the authors in this special issue of *Forest Ecology and Management* to present new work or synthesize the current understanding (or lack of it) regarding the role of disturbance, fire, or fire-related management for aquatic populations, communities, or habitats and the physical and biological processes that maintain them. Scientists and managers familiar with the issues were also invited to participate in the subsequent discussion. The final paper, by Bisson and others, provides a synthesis of the key points emerging from those papers and discussion in the context of the current ecological and management literature. The papers published here do not resolve the ongoing debate, but they provide a

foundation for a more informed and constructive dialogue that may emerge.

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