Living with Wildland Fire in America

Building new bridges between policy, science and management

By John A. Hall, Paul F. Steblein and Colin C. Hardy

In his October 26, 2017 commentary in these pages (Wildfire Magazine 26.4; 4–5), Dr. Tom Zimmerman highlights a number of ongoing and future challenges faced by wildland fire management. To address these challenges he also identifies an important role for science and in particular management-relevant wildland fire research. Here, we first briefly elaborate on Dr. Zimmerman's challenges and how they relate to new opportunities for the role of science in wildland fire management. Second, we focus on three additional institutional or "cultural" barriers or divides that could helpfully be acknowledged and addressed when forging a path forward for wildland fire research and its necessary companion: science delivery. As commenters on these matters, the authors represent only a small portion—even within the federal wildland fire science community—of those responsible for or interested in the funding, execution, and delivery of actionable science to end users. Nevertheless, we represent key programs with specific missions to serve federal wildland fire-related science, management, and policy information needs.

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Ongoing and Future Challenges

To paraphrase and amplify Dr. Zimmerman, the forces that shape our understanding of and response to wildland fire are both converging and dynamic. We live with the history of long-term fire suppression, ongoing changes in trends and variability in fuels and climate that are altering fire regimes in those ecosystems that historically experienced fire and those that didn't, and land-use patterns that increase human and asset exposure in a manner that is unsynchronized with the necessary cultural adjustments. The preceding forces interact in non-linear and complex ways, which means their future expression will be difficult to predict. These forces, and others, place new and accelerating demands on our understanding of wildland fire, its management, and response to it within both ecological and social contexts. The needs are both short-term and long-term. As a result, scientists may need to be comfortable with providing imperfect but useful information while still seeking better understanding, whereas users of science are encouraged to support both the tactical (short-term: *I need an answer now*) and the strategic (long-term: *I need to better prepare for the future*) aspects of the science enterprise. In the latter context, knowledge discovery is still a vital component; however, within the scope of wildland fire research it is still problem-driven and ultimately management/policy relevant. Finally, technological advances in such areas as computational power, unmanned platforms, and enhanced sensors facilitate our ability to better understand fire-related phenomena—e.g., the physics of fire, plume dynamics, fire effects—that can result eventually in enhanced data and tools for management and other purposes (see sidebar and Figure 2).

Much more can be said about the forces of change and the resulting challenges, as well as associated opportunities afforded by scientific and technological advances to meet those challenges; however, in the remainder of this article, we will focus on three key organizational areas that could help improve efficiency and effectiveness in the execution and use of wildland fire science.

Getting the Wildland Fire Policy, Science, and Management Communities on the Same Page

This is an age-old story and one not unique to wildland fire science. Research that is relevant to policy and management is not always equally obvious to the different communities and, depending on the degree of scientific understanding of a problem, such research is not necessarily ready to be conducted in an applied way that leads to a potential solution in the near-term. The key, whether fundamental or applied research is involved, is that the science to be performed is responsive to the problem posed by managers or policy-makers. Moreover, translating the problem or need (versus wants) into a scientific question that can be addressed by research, as well as translating research results into useful and actionable information, are both critical elements of the coproduction of knowledge by those producing and using the science. Neither of these steps may be viewed as intuitively obvious as to how they are accomplished, nor will only one approach necessarily suffice. We are learning how to do better at both—indeed wildland fire science has some good models to offer; however, improvement and ongoing commitment is still needed given the challenges articulated above.

We view the path forward as three-fold.

First, ongoing dialogue is needed between science producers (the doers, the scientists, but also the funders of research), managers, and policy-makers, not as a one-time event but over time at a frequency appropriate to ensure the continued match of research produced with needed information. Such dialogue could have the goals of:

1. Furthering the objectives of the National Cohesive Wildland Fire Management Strategy;
2. Defining a shared understanding of the critical short- and long-term challenges in wildland fire management and policy that further research can address;
3. Setting realistic expectations of the potential outcomes of such research and the timelines over which desired data and tools may be available; and
4. Defining the manner in which resultant research outcomes can be provided to ensure they are accessible, useful, and actionable.

Although this could be accomplished informally, clear and supportive leaders' intent would enhance this dialogue.

Second, new approaches to research and knowledge delivery are needed that engage both scientists and the users of their science in problem formulation, research design and execution, and interpretation and application of research results. This coproduced knowledge is not arrived at via a one-size-fits-all approach; rather, the degree of needed engagement is best tailored to the nature and our current understanding of the problem and the situation under which it is occurring. For example, is it a locally applicable and well-studied problem that can quickly have an identified solution? Or is it a poorly understood and regionally or nationally significant problem that first requires fundamental research? Regardless, in either case we will need new business models that facilitate funding and executing research in a coproduction mode. Our Australian colleagues at the Bushfire and Natural Hazards Cooperative Research Center have experience here (https://www.bnhcrc.com.au/). Our collective objective is to work with partners over the next year to explore potential models.

Third, wildland fire science has made great strides in the area of science delivery that in important ways has fundamentally advanced the practice and science of delivering actionable information to a variety of end users. Examples include Forest Service and US Geological Survey interactions between their scientists and agency managers, the fire-related projects funded by the Department of Defense's Environmental Security Technology Certification Program, a demonstration and validation program, and the national, collaborative network of 15 regional fire science exchanges (or Fire Science Exchange Network [FSEN]; see Figure 1) established and maintained by the Joint Fire Science Program. The FSEN infrastructure represents a significant investment in capacity that in the wildland fire world is unmatched in its breadth of audiences targeted and depth of information provided. Our common objectives here are to:

1. Further the integration of science delivery and translation across our agencies and programs, so that from the end-user's perspective it appears seamless and comprehensive regarding the available information;
2. Continue to innovate in the science of delivery, and
3. Expand the audiences that can be the recipients of wildland fire science.

Fire and the Land are Inextricably Linked — So Too Should Be Our Understanding and Response

Fire is an essential ecological process that to differing degrees shapes the ecology and land management responses for many of our ecosystems. Fire also is responsive to other ecological processes and land-use practices. In practice, wildland fire cannot be separated from other aspects of land management. Fire inevitably, and on its own terms if need be, will occur on the landscape. Our ability to prevent it will be temporally and spatially limited; however, by acknowledging its role in a broader ecological and social context, we may be able to shape its occurrence and effects and thereby better live with fire on the landscape. Given the history of fire suppression, we will be challenged to determine how to

Figure 1. Geographic distribution of Fire Science Exchange Networks.

use all the tools of vegetation management, including prescribed fire, to not only reduce the risk of catastrophic wildfire but also to maintain, and increase if needed, an ecosystem's resiliency under changing environmental conditions and its capacity to provide the variety of ecosystem services that society demands.

To accomplish the preceding, the linkage then also applies to the study of fire and land management and, ultimately, to how we respond to and use fire. As a result, wildland fire science and management would benefit by more explicit and purposeful integration with other discipline/management areas—hydrology, soils, species biology, and so on—for which fire plays a role but is not the sole focus. Integrating applicable disciplines can help address issues such as invasive species and how they may alter fire regimes; post-fire effects on erosion, debris flows, watershed health, and vegetation recovery; fire-atmospheric interactions; and the human dimensions of fire. Decisions on land-management actions will require similar integration. The fire science and management communities are well served by crossing the hall and talking with their colleagues that do not live and breathe fire on a daily basis. It is better to avoid silos around land management versus fire management, in addition to the walls between science and management. Science, especially if research is conducted in a coproduced manner, can assist in strengthening the linkages between fire and land management.

Agency and Program Silos are Impediments to Effectiveness and Efficiencies

When faced with scarce resources, we may tend to focus on a tighter circle of responsibility. So understandably would agencies and programs that must be responsive to their specific missions. In addition to the need for increased and ongoing dialogue between policy, science, and management, we also see benefits to be gained from increased coordination and leverage across those agencies and programs involved in wildland fire science. This can be accomplished while still being responsive to agency missions, at the same time working to improve efficiency and effectiveness.

We have started this collaborative work among ourselves and in some cases with other agency partners. For example, the Western Wildfire Campaign is a collaborative effort during 2018 and 2019 among the Joint Fire Science Program, Forest Service, National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, Environmental Protection Agency, and National Science Foundation to advance the understanding of the chemistry of smoke, its temporal changes (or aging), and transport and their relationships to fuel characteristics and consumption. For the future, we look to develop new models of how to work together.

In closing, we suggest that the challenges facing the nation with respect to living with fire in a rapidly changing world require new paradigms for how the fire science community needs to respond to ensure users of science—practitioners, managers, and policy-makers and their advisors—have the requisite information they need to make informed decisions. We highlighted three institutional divides that are potential impediments and offered our perspectives on how these divides may be bridged. In the end, it will take the efforts of many others besides ourselves to build these bridges. In so doing, we honor the "Cohesive" part of the National Cohesive Wildland Fire Management Strategy.

An example of **adaptive wildland fire science**: *The National Fire Danger Rating System*

The United States National Fire Danger Rating System (NFDRS) is used nationwide to guide wildland fire preparedness and response decision-making. The modular system was developed to rapidly deliver the best available science to fire managers while providing opportunities to improve individual components when better models were available.

The original NFDRS developers recognized that a standardized national system was needed, but they also knew that some of the components necessary for a high-quality system were incomplete or primitive. For example, at the time no generalized methods for modeling live fuel moisture existed that could be integrated into a nationwide system. Much of the other science at the time, however, was robust and suitable for delivery to the field; therefore, they developed the system with the best information available at the time and created a framework in which future innovations could easily be integrated into the system.

Since its inception in 1972 and updates in 1978 and 1988, science and technology have improved. Remote weather stations are now telemetered by satellites, models of both live and dead fuel moistures have improved, and we have increased our understanding of fire danger applications best practices. Now, since 2016, scientists and applications developers built upon this modularity of NFDRS and released an improved version of the system that addresses many of the early constraints of the system (see Figure 2 [Sidebar], below). Although imperfect, it provides managers with the critical information they need to make well-informed decisions. This new system itself will be improved over time as additional science and technology advancements become available.

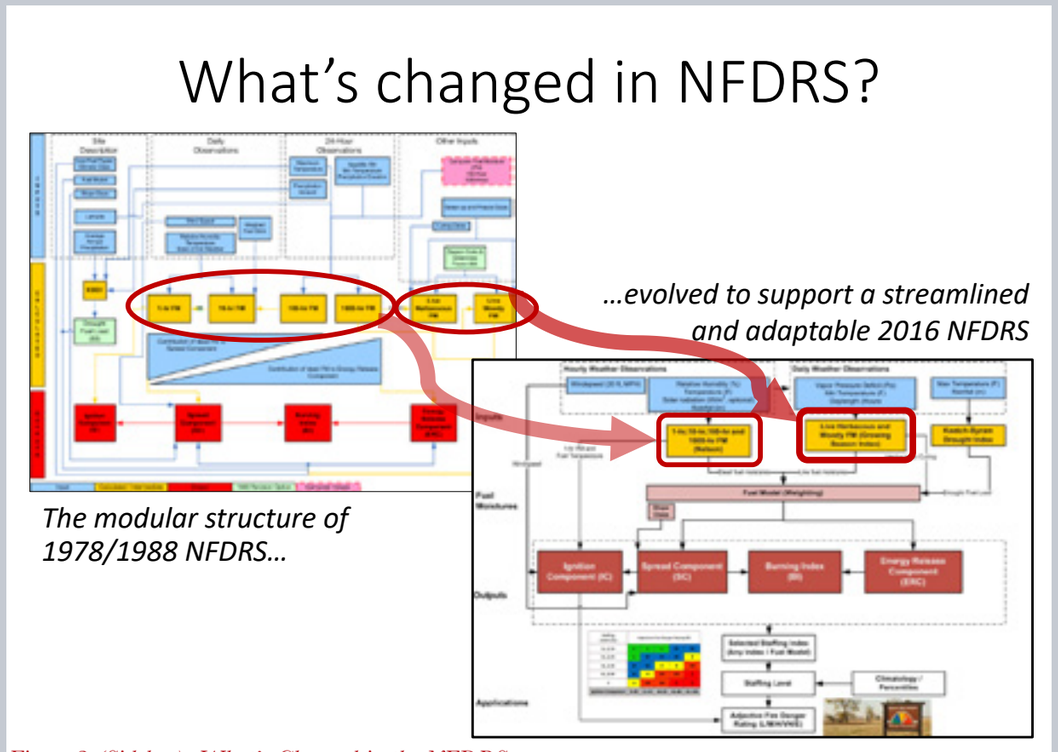

Figure 2 (Sidebar). What's Changed in the NFDRS.