

Project Title: Fire and Aquatic Ecosystems in the Context of Climate Change: A Synthesis for Improved Management

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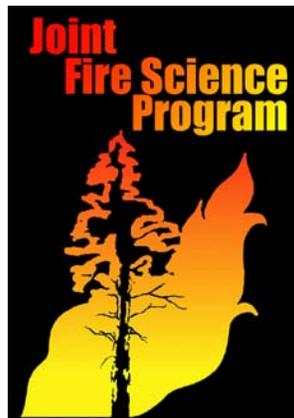
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Abstract

Fire will be the proverbial eye-of-the-needle through which many western U.S. mountain, forest, and stream ecosystems will pass as the climate changes. Historic observations show increased dryness and temperatures accompanying more widespread fire and forest die-off. These events may punctuate gradual changes to ecosystems, or may be a mechanism driving stepwise changes in ecosystems. Most western ecosystems are strongly tied to cycles of fire and recovery, and the changing nature of fire will have profound consequences. There is no question that vulnerability assessments of western U.S. ecosystems need to account for fire in their calculus.

The biophysical template of the forest, riparian, and stream ecosystems determines much of the response to fire. The degree of forest adaptation to fire, including fuel loading, fuel continuity, and species mixes are clear determinants of fire spread, fire severity, and the forest's response. For aquatic systems the relative spatial scales of fire and connected fish habitats form another critical factor in long-term population persistence. Terrain, climate, and geology all exert controls on the hydrology of both forests and streams which sets much of the stage. Land and water management alter these contexts, sometimes dramatically, particularly those associated with scales of fuel continuity and aquatic fragmentation. Intertwined are the roles of invasive terrestrial and aquatic species and their roles in changing the scales of events and the connectivity and size of populations.

Adaptation to climate change in the combined context of fire and climate change takes on greater dimensionality than management for either alone. Conceptually the detrimental contributions of prior human interventions provide substantial fodder for corrective action in anticipation of future severe events. However, an equally strong conceptual argument notes that restoration to historical conditions is itself an unstable solution at best. Despite clear knowledge that resistance, for example in the form of fire suppression, has built an unsustainable legacy of risk, resistive techniques will necessarily play future roles because the contexts are changing so fast. Sustainable approaches will rely on activities encouraging resilience in forests, riparian habitats, and streams alike, as opposed to those benefiting one ecosystem component at the expense of another. We also need to understand how human activities, even seemingly nurturing ones, can interfere with basic dynamic processes that form the foundation of resilience in fire adapted ecosystems.

By understanding the processes reducing vulnerability to both severe disturbance and climate change, we can begin to envision many ways to facilitate more reliable positive outcomes for fire and related ecological dynamics. The future will likely require an increasing number of rapid decisions with a great deal of uncertainty about what will happen in the future, which would suggest that a present focus on reducing uncertainty about current resource conditions and limitations would be a wise investment.

Adaptation taken in its most commonly used sense is about evolving, which is to say it is about learning; learning what works best. A principal goal of this GTR is to describe the framework of how we think that fire and climate change work together to affect fish communities. Learning will come from testing, probing, and pushing that framework to understand how it doesn't work and then proposing new ideas.

The western U.S. is a big place, with many diverse landscapes, defying generalizations and much learning must necessarily be local in implication. We present what we hope serves as a scaffold for that learning.

This GTR comprises 2 parts: An overview document speaking to the breadth of processes interlinked by forests, fish, fire, and climate change, and a brief series of more specific and scholarly papers describing the biological interactions of fish, fire, and land management in more detail. Any one of these documents could stand on its own. Taken together they serve as a useful reference with varying levels of detail for land managers and resource specialists.

Background and Purpose

Managing the balance between aquatic resources, wildfire, and fuel conditions has always been difficult, and is becoming further complicated by changes in climate that alter both aquatic ecosystems and wildfire characteristics. An important question is how we expect the changing nature of fire in the landscape and our shifting management responses to interact with the changing hydrologic and aquatic systems. Multiple federal agencies face this challenge and are looking for solutions. Several summaries of the effects of fire on aquatic ecosystems exist (Minshall et al., 1997, Gresswell, 1999, Rieman et al, 2003, Luce, 2005, Shakesby and Doerr, 2006). Since the last major summary, many results have come from National Fire Plan and Joint Fire Sciences Program funded studies. In addition a great deal has been recognized about the nature of climate change, how it affects fire, and how it directly affects aquatic systems. Finally, the fire management community has made dramatic changes in their approach to wildfire using Appropriate Management Response, giving fire a much larger role in landscape-scale vegetation management. Within hours of weather updates, decisions are now made that affect thousands to tens of thousands of acres. The stakes are higher and the decisions more complex. There is a need for an updated review and synthesis of how fire affects aquatic ecosystems, how it interacts with land, fuel, and fire management decisions, and how this all fits into the context of a changing climate. We prepared a synthesis and several focused papers highlighting recent research on fish and wildfire. We also conducted a workshop with line officers and specialists to provide updated information and syntheses supporting management policies and decisions incorporating the best available science.

Study description and location

The project had two components: (1) a workshop with land and aquatic managers, (2) a synthesis of current research for managers. The purpose of the workshop was to gather insights about what was helpful from previous synthesis efforts, and what was needed from new synthetic work. Presentations from the workshop are included as deliverables. The written synthesis comprises four principle parts: (1) An overview and discussion of the different management concerns that come into play for managing for changing fire, (2) a multidisciplinary technical review of concepts and recent papers providing information about climate, fire, forests, riparian areas, hydrology, geomorphology, and fish, (3) several

detailed papers on aspects of fish and fire interactions, and (4) management concepts including easily applied next steps. The more technical portions are intended to be relatively accessible outside of the disciplines and are meant to provide entry to the literature for specialists who may need more detailed information. The Endnote citation file is also included as a deliverable to assist in preparing NEPA specialist reports. Conceptual and technical figures will be made available separately to assist with public meetings.

Key findings with one-two paragraph discussion of each

From the workshop, it was clear that managers from all disciplines and line officers had a relatively clear understanding of the complexity of the issues facing them in managing for fish and fire in a changing climate. They had few questions about how to achieve results on the landscape, even where the fish, forests, and riparian areas were particularly sensitive. The managers were all familiar with the existing literature on fish and fire, and their purposes, goals, methods, and reasoning for their projects were largely in concordance with the recommendations from the synthesis team. They did express some concern and uncertainty about what changes in climate might mean for the success of the projects.

The managers agreed that their primary problem was a lack of time and materials for explaining the complexity of the issues to the public (with varying levels of education) and being able to explain the technical reasons for the design choices made for projects. There was also interest in improving communications about technical issues across disciplines for similar reasons. They were interested in access to figures, references, and a brief summary of scientific results that could be brought to meetings or provided to the public to help explain why they were proposing the various projects. They were less interested in advice on how to proceed or design projects than in materials that would help them

Generating the summary and synthesis of new research and further interaction with managers produced a few new ideas that were not covered at the workshop. Among these was the notion that many climate change projections have substantial uncertainty, and what that means for both forests and stream habitats is a great deal of uncertainty about how different threats may manifest. Another was that many managers were spending more of their time responding to fires, insect attacks, and other mortality events than actually planning and preparing. They noticed that the bottlenecks were preparing NEPA reports and reconciling emergency response actions with an outlook for the longer-term. The synthesis portion of the GTR addresses this apparent conflict and should help bolster and guide policy changes already occurring in the Forest Service, BLM, and Fish and Wildlife Service to provide decision support information for managers both responding to and planning for the consequences of climate change. Specifically, managers wanted faster access to information about conditions in their streams and forests and the known and projected vulnerabilities. They wanted to be able to summarize and display information about those conditions rapidly to support their decision making and to support explanation to cooperating agencies and affected publics.

Management implications

A primary management implication is the need for easier access to information about existing forest, riparian, climate, and stream conditions. Increasing variability in climate is leading to more fires and more mortality through other processes, such as insects and disease. As a consequence many land managers are spending more time reacting to circumstances in their landscapes, reducing the time they have available to carefully obtain data and plan. Many managers have already read a large number of syntheses discussing resilience and how to achieve it, and the interdisciplinary environments in land management agencies have cultivated some sensitivity to complex interactions between streams and forests. What managers lack is a direct means to share that understanding with diverse stakeholders and the means to provide information about the most pressing problem areas to regulators and publics. Having current information about fish populations, stream conditions, riparian stands, and rangelands would be a useful addition to the currently available information about forests. Many also lack easy access to information about local climate and climate trends as well.

Relationship to other recent findings and ongoing work on this topic (one to two pages)

The documents produced for this synthesis have cited much of the recent work on the various fields of research bearing on the general problem. There were more than 570 references cited in the documents prepared, so it is a fairly thorough discussion of past and recent research. It separates itself from many related reviews of climate change and land management through its thoroughness and its focus on fairly practical solutions to dilemmas. It also stands apart in suggesting that substantial gains could be made in improving fuel, fire, riparian, and aquatic management by improving information feedback processes for resource conditions, and that potentially one of the better adaptations for climate change with respect to this complex nexus of resources is better preparing managers to make decisions. In contrast, many previous climate change syntheses have focused on changes that could be made to the landscape to make it more resilient. Because some climate changes are uncertain, and because fires and related disturbances may be the key change points to manage with respect to climate change, managers who are able to act rapidly with sound information, potentially even during Appropriate Management Response events, will produce the best outcomes for forest, riparian, and aquatic ecosystems.

It is hoped that the synthesis has also provided researchers some basis for ongoing and future work by highlighting key issues and points of uncertainty. Claiming success on that point may be premature, however.

Future work needed

Placing the technical parts of the document into a wiki-like environment where the citations and science could be updated regularly, potentially by those providing the new scientific findings, may be useful to managers. Such a format would also ease access to figures for public meetings.

The deliverables crosswalk table (list all deliverables identified in your proposal and the status of each, plus additional deliverables you have created)

GTR – substantially complete, in review for publication through the Forest Service.

Papers on fish and fire (4) augmenting the detail available in the GTR.

Workshop with managers in March, 2009 and presentations from the workshop

We did not complete the Wikipedia-like access goals of the project, nor have we completed shorter summaries of the synthesis targeted at Fire Management Today and a peer-reviewed journal. We do, however, plan to follow up on those parts of the project once the GTR has been produced. Its thoroughness provides some foundation for us to be able to publish distillations of its suggestions.