Invited Feature

The national Fire and Fire Surrogate study: ecological consequences of fuel reduction methods in seasonally dry forests[1]

This Invited Feature focuses on the U.S. national Fire and Fire Surrogate study (FFS), a multi-site multidisciplinary research project that evaluates the ecological consequences of prescribed fire and its mechanical surrogates, treatments that are intended to reduce fire risk and restore resiliency in seasonally dry forests. A comprehensive national FFS study is needed because no large comparative studies have been conducted on alternative fuel reduction methods, even though these methods have been in widespread use by forest management agencies for many years in an effort to mitigate forest conditions that are undesirable and unsustainable. In particular, structure and composition of forests that once experienced frequent, low–moderate-intensity fire regimes have been altered by fire suppression or exclusion, livestock grazing, and preferential harvest of large-diameter trees. These practices have increased tree density, decreased overall tree size, changed species composition, and increased fuel loads. Conservative estimates place over 10 million hectares of forests in the United States in an elevated fire hazard condition, and much of this land area is widely thought to need some form of active management such as prescribed fire, mechanical treatments, or both.

The primary goal of the FFS study was to measure and compare the effectiveness and ecological consequences of commonly used fuel reduction treatments. Forest managers throughout the United States have asked for side-by-side comparisons of treatments to better understand the ecological and economic considerations for applying fuel reduction and forest restoration treatments. The intent of FFS fuel reduction treatments was to reduce potential fire risk and create forest structures that are more resilient to disturbance. Similar treatments were applied across a network of sites that included seven sites in the western United States and five sites in the eastern United States. The seven western FFS study sites, although differing in elevation, tree species composition, and productivity, are located in seasonally dry forests that include ponderosa pine (*Pinus ponderosa*). The five eastern FFS study sites include two dominated by hardwood trees and three dominated by pines. For a map and description of the FFS study sites and treatments, see Schwilk et al. in this Invited Feature.

At each of the 12 FFS study sites, treatments were designed and implemented to produce stands such that 80% of the residual dominant and co-dominant trees would survive a wildfire under 80th-percentile fire–weather conditions. The treatments were conducted in cooperation with local experts, including fire management personnel, fuel specialists, and silviculturists. The core treatment design included mechanical treatment only (usually thinning from below), prescribed fire only (surface fire), a mechanical plus prescribed fire treatment, and a control (untreated). One site at Sequoia National Park implemented fall and spring fires with no mechanical treatments. Treatments were assigned randomly to at least three replicate units, each measuring at least 15 ha. Treatment effects were measured for a wide variety of variables at the 12 sites, including trees and associated understory vegetation, the fuel bed and coarse woody debris, soils, bark beetles, and small mammal and avian species.

The four contributions to this Invited Feature include three papers that compare response to treatment across multiple sites and one paper that describes a response at a single site. Forest structure response is explored in Schwilk et al., who describe how alternative fuel reduction treatments alter forest structure, invasive species, and the fuel bed across the 12-site FFS study network. If the management goal is to quickly produce stands with fewer and larger-diameter trees, less surface fuel mass, and greater herbaceous species richness, the mechanical-plus-fire treatment gave the most desirable results. However, because mechanical-plus-fire treatments also favored alien

[1] Reprints of this 76-page Special Feature are available for $10.00 each, either as PDF files or as hard copy. Prepayment is required. Order reprints from the Ecological Society of America, Attention: Reprint Department, 1990 M Street, N.W., Suite 700, Washington, D.C. 20036 (esaHQ@esa.org).

species invasion at some sites, this negative effect should be considered when developing treatment strategies.

Working with post-treatment fuels and stand structure data from six of the western sites, Stephens et al. use a fire behavior model (FMA+) to demonstrate that mechanical-plus-fire, fire-only, and mechanical-only treatments using whole-tree harvest systems were all effective at reducing potential fire severity under severe fire weather conditions; retaining the largest trees within stands also increased fire resistance. A review of the effectiveness of fuel treatments on actual wildfires supports these conclusions.

Working at the Blue Mountains site, Youngblood et al. use structural equation modeling to explore the relationships among factors behind treatment-induced tree mortality. The authors demonstrate that the probability of mortality of large-diameter ponderosa pine from bark beetles and wood borers is linked to treatment, because of how thinning and prescribed fire influence fuel mass and fire severity.

Boerner et al. report that soil structure and chemistry is highly variable across the network of 12 study sites, with soil bulk density varying by twofold among sites, soil carbon by fourfold, total inorganic nitrogen by 10-fold, and micronutrients by more than 200-fold. When treatment response is evaluated within this context, ecological effects appear to be subtle and transient, with the combined mechanical plus fire treatment causing the greatest magnitude of effects.

Many of the conclusions in these four papers are supported by a variety of site-level papers published over the past four years, describing short-term effects of fire and fire surrogate treatments on vegetation, fuels, soils, wildlife, insects, and forest pathogens. Readers are referred to the Literature Cited sections in the papers included in this Invited Feature.

The FFS treatments were not primarily designed to restore forest structure to presettlement conditions (i.e., before 1850). The goal of the treatments was to achieve a specific proportion of mid- and upper-canopy trees to survive wildfires under a stated set of fire–weather conditions, thereby increasing forest resistance. Designing more fire-resistant stands and landscapes will likely create forests more resistant to stresses imposed on them by changing climates. For this reason, it is more appropriate to design and test a range of specific forest structures to learn about their resistance and vulnerabilities, rather than restoring them to a presettlement condition that may not be appropriate for the future.

Several recent fire policies and initiatives such as the National Fire Plan, Ten-Year Comprehensive Strategy, Healthy Forest Restoration Act, and the Joint Fire Science Program have been enacted to address the national U.S. wildfire management challenge. Managers who are confronted with uncertainties in wildfire effects across vast forested landscapes and are challenged to consider fire within the context of complex ecological and social frameworks continue to seek opportunities to ensure that key ecosystem services are provided and values preserved. The national Fire and Fire Surrogate study is providing answers to many of the important questions that surround the issues of fuel reduction and dry forest restoration and management.

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