

# JFSP Project Highlights

## Research Supporting Sound Decisions

July 2004

Joint  
Fire Science  
Program



The JFSP, a partnership of six federal wildland fire and research organizations, provides scientific information and support for fuel and fire management programs.

### JFSP Contacts

Bob Clark  
Program Manager  
208-387-5349

Becky Jenison  
Program Assistant  
208-387-5958

Tom Wordell  
Fire Technology  
Transfer Specialist  
208-387-5865

[jfsp.nifc.gov](http://jfsp.nifc.gov)

### Modeled Changes to Canopy Fuels in Arizona Estimate Crown Fire Behavior Over Time and Assess Ecological and Management Implications

This study modeled changes in canopy fuels (canopy biomass, canopy bulk density, species composition) and potential fire behavior (crowning index) over a 160-year period from 1880 to 2040 utilizing study sites located on the North Rim of Grand Canyon National Park in northern Arizona. The study spanned a 500-meter gradient in elevation to include ponderosa pine forests through higher elevation mixed conifer, aspen and spruce-fir vegetation types.

A schematic diagram is included here that depicts the forest data collection and modeling process used. Forest change was simulated on a per-plot basis (166 plots total) at 10-year intervals using the Forest Vegetation Simulator (FVS) with the Central Rockies variant. Simulations were initialized with reconstructed 1880 conditions and then run adding regeneration data until 2040. Simulations were found to be relatively accurate (+ 20% of field values for tree density and basal area) after comparing outputs for the year 2000 with field data collected from 1998-2002. The Nexus Fire Behavior and Hazard Assessment System was used to model fire behavior under extreme (90th and 97th percentile weather) conditions. The project focused on crown fire behavior, measured by the crowning index (CI), since it was thought to be a reliable fire behavior variable. Crowning Index is defined as the wind speed at which active canopy burning could be sustained.

The most dramatic changes in canopy biomass were found to be at the higher elevation sites. On average, canopy biomass increased 279% on these sites compared to an average increase of 122% at the lower elevation sites. As expected, canopy bulk density values closely paralleled canopy biomass values with minor variations. Species composition also differed by elevation. Very high wind speeds were required for crown fire spread at all sites in 1880. However wind speeds needed to sustain crown fire spread decreased from 23% to 86% by the end of the simulation period (2040), depending on the site. Modeled across the entire North Rim area, 33% of the landscape was susceptible to crown fire spread at a wind speed threshold of 45 km/h (28 mi/h) in 2000, compared to less than 6% in 1880 (see figure at right). Wind speeds of 45 km/h or more have been found to be common as gusts and occasionally as sustained winds in northern Arizona during severe fires.

There are numerous ecological and management implications from this study. For example, the historical shift towards mesic species is likely to have lowered crown base heights facilitating an increase in crown fire initiation. Also, the data suggest that in ponderosa pine dominated sites even if relatively intense fires resulted in a substantial reduction of canopy biomass (up to 40-50%), the resulting forest conditions could still be within the range of historic conditions if older trees tended to survive.

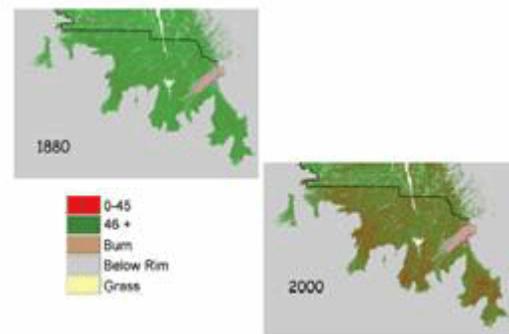
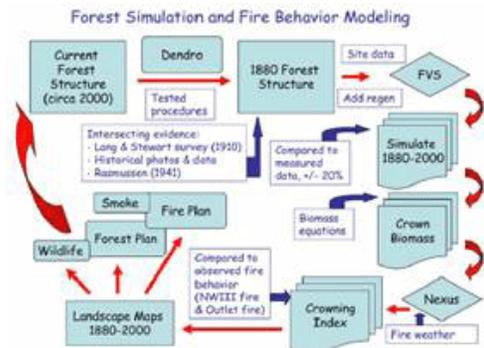
Principal Investigator:

• Dr. Peter Z. Fulé – Northern Arizona University

Reference: Fulé, P.Z., J.E. Crouse, A.E. Cocke, M.M. Moore, and W.W. Covington. 2004. Changes in canopy fuels and potential fire behavior 1880-2040: Grand Canyon, Arizona. *Ecological Modelling* 175:231-248.

You can obtain further information at: [http://www.for.nau.edu/research/pzf/Fule\\_web/Reprints/Fule\\_EcolMod2004.pdf](http://www.for.nau.edu/research/pzf/Fule_web/Reprints/Fule_EcolMod2004.pdf)

Download a printable version of the JFSP Project Highlight Newsletter at <http://jfsp.nifc.gov/news/doc/highlight.pdf>. Download previous JFSP Project Highlight Newsletters at <http://jfsp.nifc.gov/news/archieve.htm>.



Comparison of crowning index values, km/h, on North Rim forests in 1880 (relatively resistant to crown fire) and 2040 (relatively susceptible to crown fire). The large area classified as "burn" is the outlet fire, which burned in May, 2000.