

FINAL REPORT, JOINT FIRE SCIENCE PROGRAM AFP3-2001C

Project Title: Fire regimes & forest structure of Utah & eastern Nevada: A multi-scale history from tree rings

JFSP Project No.: 01C-3-3-22

Project Locations: We reconstructed fire and forest histories from tree rings at 17 sites in Utah and 1 site in eastern Nevada (see appendix). These sites were located on 5 national forests, 3 districts of the Bureau of Land Management, and 1 national park. These sites were located in all three US Congressional Districts in Utah plus one district in Nevada. Data analysis was conducted at the Fire Science and Shrub Sciences Laboratories, Rocky Mountain Research Station, USDA Forest Service, Missoula, MT and Provo UT; and at Rocky Mountain Tree-Ring Research Inc., Fort Collins, CO.

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SUMMARY OF HOW WE MET OUR PROPOSED OBJECTIVES

Objective 1 was to reconstruct multi-century histories of fire and forest structure across a range of topography, forest type and regional climate in 10 sites in Utah and eastern Nevada, from tree rings.

- From 18 sites, we sampled 11,767 trees to determine their recruitment dates and 1,175 fire-scarred trees (Figure 1). We sampled these trees at 405 plots that included a broad range of topography and 17 different biophysical settings, ranging from shrubland and sagebrush steppe to spruce-fir forests. We were able to exceed our JFSP objectives for sampling by leveraging JFSP funding with additional funding from the Fishlake National Forest, Utah State Bureau of Land Management, and Rocky Mountain Research Station.
- Our study is unique in being *both* intensive at the local scale and extensive at the regional scale.

Objective 2 was to scientifically assess the extent to which fire and forest-structure histories can be extrapolated to unsampled areas, by elucidating the drivers of spatial variation across the areas that we sample.

Spatial variation in historical fire regimes and forest structure of Utah and eastern Nevada

- Our objective was to elucidate the multiscale drivers of spatial variation in historical fire regimes and forest structure in Utah and eastern Nevada, including climate, vegetation and landscape physiography.
- Exploratory data analysis shows that fire regimes varied by forest type, elevation, and local moisture regime in a regionally consistent manner.
- We are currently quantifying these relationships statistically.

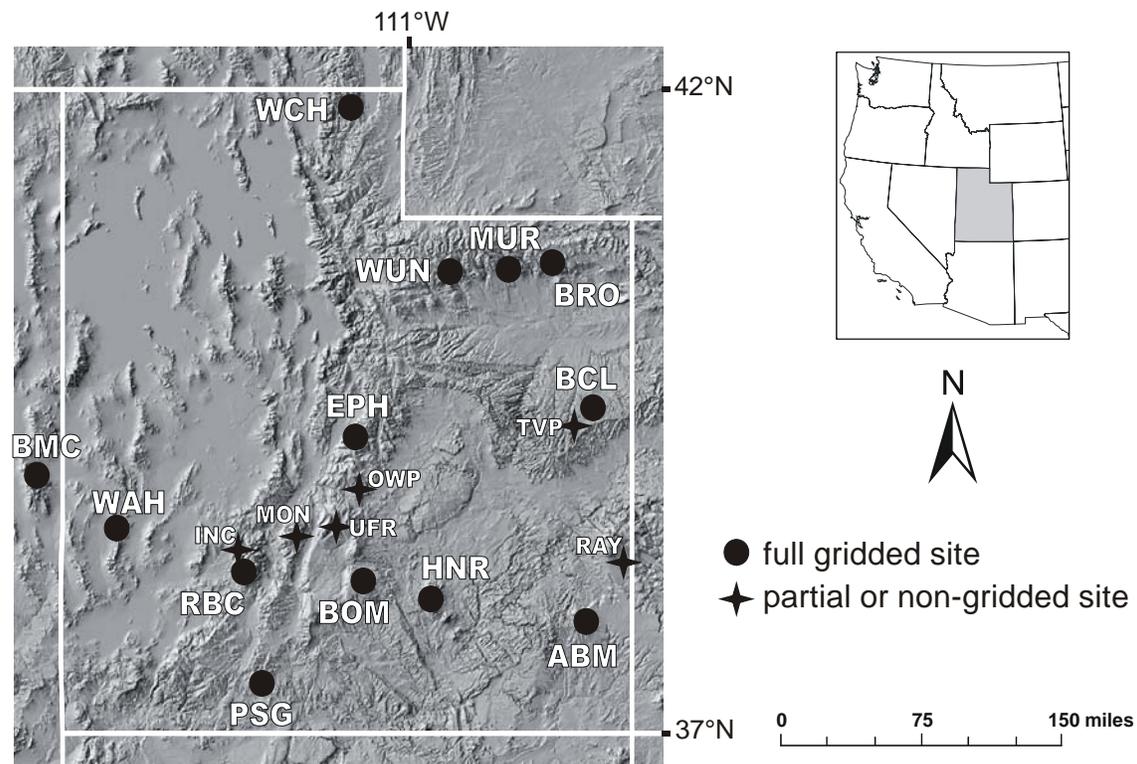


Figure 1. Location of fire and forest history sampling sites in Utah (shaded state in inset map) and eastern Nevada.

Climate drivers of spatial variation in historical fires (1630-1900) in Utah and eastern Nevada

- We identified climate effects on fire occurrence from 1630 to 1900 for our new set of crossdated fire-scar chronologies from 18 forested sites in Utah and one site in eastern Nevada.
- Years with regionally synchronous fires (31 years with fire recorded at $\geq 20\%$ of sites) had significantly drier summers, and years with no fires at any site (100 years) were significantly wetter than average.
- Antecedent wet years also had a significant effect on regional fire occurrence through buildup of fine fuel amount and continuity.
- NINO3 (an index of the El Niño-Southern Oscillation; ENSO) was significantly low during regional fire years (La Niñas) and significantly high during non-fire years (El Niños). NINO3 also was high during years prior to regional fire years. Although regional-fire years occurred nearly twice as often as expected when NINO3 and the Pacific Decadal Oscillation (PDO) were both in their cool (negative) phases, the difference was not significant.
- Low PDSI was important for fire occurrence across sites. However, ENSO forcing was strongest in sites in the southeastern portion of the study area.
- Our results largely support findings from previous fire/climate studies, and support the probable importance of a pivot point in Pacific basin teleconnections at $\sim 40^\circ\text{N}$.

Provide our data to LANDFIRE

- Kitchen provided review and revision for 11 LANDFIRE Rapid Assessment Model descriptions; participated in a workshop in Salt Lake City, UT (February 22-24, 2005) to revise LANDFIRE models for forest, woodland, and shrublands in the Utah Mountains and High Plateaus and Great Basin Zones. In addition, he engaged in critical discussions regarding the mountain big sagebrush model for the Northern Rockies Zone and the need for inter-zonal crosswalks in the development of LANDFIRE models.
- Brown organized and led a workshop for LANDFIRE and National Interagency Fuels Technology Team employees: Field Methods for Assessment of Fire Regime Condition Classes: Historical and Existing Vegetation, Fire History and Reference Conditions. Silver City, NM, September 25-29, 2006.
- We are currently discussing with LANDFIRE the best way to provide them our data for validation and testing of the landscape dynamics models that they use to compute fire regime condition classes. This is likely to take the form of a project funded by the Fire Modeling Institute (Rocky Mountain Research Station) to use our data in a gradient model.

Objective 3 was to communicate the results of our work to wildland managers in Utah and eastern Nevada. We proposed to hold a final workshop for federal land-managers from NFS, BLM, BIA, NPS and the public. However, after discussions with local managers about how best to meet their needs, we will instead make presentations at the regularly scheduled spring meetings of the five BLM and NFS fuels committees that cover the state of Utah. We have already presented many talks to managers and others (see list below for a summary and the table of deliverables for details). In addition, we will publicly archive our data.

- 13 talks to regional, national, and international scientific and professional meetings
- We attended the one JFSP Principal Investigator Conference that we were requested to attend and plan to attend the next one in March 2007.
- Kitchen taught a class on fire ecology at Great Basin National Park July 18, 2002 and one on forest ecology (with fire as an important element) on July 16, 2003. These classes were targeted for the general public but had some park personnel attend as well.
- L.M. Chappell (Interagency Fuels specialist, Richfield District Office BLM and Fishlake National Forest) and R.B. Campbell (Forest Ecologist, Fishlake National Forest) have used our findings to:
 - Estimate fire regimes condition class departure from historic range of variation at project and landscape levels
 - Update fire management plans at forest and local levels
 - Prepare specialist reports
 - In NEPA documentation required for planning and implementation of Wildland Fire Use

New items not proposed but partially funded by JFSP

- Of our total sites, 3 full-gridded sites and 1 partial-gridded site were sampled with additional funding we received from the Utah State Bureau of Land Management and the Fishlake National Forest.
- We crossdated and analyzed samples already collected by the Fishlake National Forest from one site in Utah (MON).

- Kitchen will include data from two of the gridded sites (WAH and BMC) in his Ph.D. dissertation (Brigham Young University): Historical fire regimes in two eastern Great Basin (USA) fire-sheds: regional patterns and local variation.
- While sampling at RBC, we spent several hours collecting old Engelmann spruce samples that will be used for climate reconstruction by Brown and others.
- While sampling at WAH we spent several hours collecting increment cores from 178 additional Great Basin bristlecone pine trees that will be included in a study of bristlecone pine-fire interactions.

Extensions to this work not funded by JFSP

- Connie Woodhouse of NOAA Paleoclimate Program is using old trees we collected in our plots at BCL to reconstruct drought and streamflow over the Four Corners area.
- Tyson Swetnam used our recruitment dates and species composition to characterize biophysical setting and existing vegetation type at all of our plots and compared these with values assigned by fire regime condition class and LANDFIRE. (Swetnam, T.L. 2006. Fire Regime Condition Class accuracy: A comparison to tree-ring fire histories. M.S. Thesis, The University of Arizona, Tucson, Arizona.). Swetnam and Brown are currently preparing the thesis for publication in International Journal of Wildland Fire.
- Tony Westerling is using our fire-scar dates to validate his models of the climate drivers of fire in the Western US. (Westerling, A., E.K. Heyerdahl, and P. Morgan. Applied dendrochronology for fire management in the western United States. Oral presentation at the 3rd International Fire Ecology and Management Congress. San Diego, CA (11/13-17/06)).

DELIVERABLES

We have included copies of these deliverables on CD except those deliverables that have not yet been completed or are not yet available (i.e., have not yet been accepted for publication).

Proposed	Delivered	Status
<p>Provide written reports, maps and data to each of the units on which we sampled.</p>	<p>(1) <u>Final report to Fishlake National Forest</u>: Heyerdahl, E.K., P.M. Brown, S.G. Kitchen, and M.H. Weber. April 2005. Historical Fire Regimes and Forest Structure, Fishlake National Forest: Final Report on a Pilot Study. Final report to Fishlake National Forest, Utah. 62 p., incl. maps.</p> <p>(2) <u>Final report to BLM</u>: Heyerdahl, E.K., P.M. Brown, S.G. Kitchen, and M.H. Weber. March 2006. Fire regimes and forest structure of Utah and eastern Nevada: A multi-scale history from tree rings. Final report to Utah State Bureau of Land Management. 241 p., incl. maps.</p> <p>(3) <u>Rocky Mountain Research Station general technical report (GTR) on DVD</u> (this will be an expanded version of the BLM final report and will include all data, site and fire maps, plot photos, and associated metadata).</p>	<p>(1) Fishlake_final_report.doc</p> <p>(2) heyerdahl_BLM_final_report_2006.pdf</p> <p>(3) submission in 2007</p>
<p>Publish manuscripts in peer-reviewed journals</p>	<p>Brown, P.M., E.K. Heyerdahl, S.G. Kitchen, and M.H. Weber. Climate effects on historical fires (1630-1900) in Utah. International Journal of Wildland Fire</p> <p>(1) Heyerdahl, E.K., P.M. Brown, S.G. Kitchen, and M.H. Weber. Fire regimes and tree recruitment in Utah forests. Ecological Applications.</p> <p>(2) Kitchen, S.G., P.M. Brown, E.K. Heyerdahl, and M.H. Weber. Historic fire regimes and post-settlement conifer encroachment in southern mountain big sagebrush communities. Rangeland Ecology and Management.</p> <p>(3) Brown, P.M., S.G. Kitchen, and E.K. Heyerdahl. Climate, fire and tree recruitment in pinyon-juniper woodlands of Utah. International Journal of Wildland Fire</p>	<p>(1) submitted Oct 2006 (Brown_IJWF_abstract.rtf)</p> <p>(2) submission in 2007</p> <p>(3) submission in 2007</p> <p>(4) submission in 2007</p>

<p>Present findings at regional, national, and international scientific and professional meetings</p>	<ol style="list-style-type: none"> (1) Heyerdahl, E.K., S.G. Kitchen, P.M. Brown, and M.H. Weber. 2005. "Fire Regimes and Forest Structure of Utah and Nevada: A Multi-scale History from Tree Rings." Department of Geography Seminar Series, University of Colorado, Boulder, CO (November 5, 2003). (2) Weber, M.H., E.K. Heyerdahl, P.M. Brown, S.G. Kitchen. 2004. "Variation in Historical Fire Regimes across an Elevation and Forest Gradient in Utah." 89th Annual Meeting, Ecological Society of America, in Portland, OR (8/1-8/6/04). (3) Brown, P.M. 2004. "Defining Scales: Time, Place, and Bottom-up Effects on Fire Regimes." Mixed Severity Fire Regimes: Ecology and Management Conference, in Spokane, WA (11/17-11/19/04). (4) Brown, P.M., February 24, 2005. "HRV data from tree rings: Methods and issues"; USDA Forest Service Region 2 Botanists and Ecologists Meeting, Fort Collins, CO. (5) Kitchen, S.G. participated in Region 4 Workshop for revision of Properly Functioning Condition Documents, January 24-26, 2006, Ogden, UT, and follow-up discussions and revision assignments. (6) Kitchen, S.G. participated in Wasatch and Uinta NF sponsored Wasatch Front Fuels and Weeds Roundtable, February 27, 2006, Ogden, UT and helped draft and review white paper. (7) Kitchen, S.G., E.K. Heyerdahl, P.M. Brown, and M.H. Weber. 2006. "Fire Regimes & Forest Structure of Utah & eastern Nevada: A multi-scale History from Tree Rings. Region 4 Integrated Resource Workshop, Ogden, UT. (March 27-31, 2006). (8) Kitchen, S.G., P.M. Brown, E.K. Heyerdahl, and M.H. Weber. 2006. "Historic Fire Regimes and Post-settlement Conifer Encroachment in Southern Mountain Big Sagebrush Communities". Fourteenth Wildland Shrub Symposium. Cedar City, UT. (June 6-8, 2006). (9) Kitchen S.G., E.K. Heyerdahl, P.M. Brown, and M.H. Weber. 	<p>1 through 12 done, 13 to be presented in April 2007</p>
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	<p>2006. "A Burning Legacy: Historic Fire Regimes and Forest Structure on Southern Utah Landscapes". Dixie and Fishlake National Forests, Forest Plan Forum, Cedar City, UT (June 28, 2006).</p> <p>(10) Brown, P.M., 2006. "Climate and disturbance effects on tree recruitment and mortality", 7th International Conference on Dendrochronology", Beijing, China (June 2006).</p> <p>(11) Brown, P.M., S.G. Kitchen, E.K. Heyerdahl, and M.H. Weber. 2006. "Fire climatology across local to regional gradients: Separating top-down from bottom-up forcings". 3rd International Fire Ecology and Management Congress, San Diego, CA (November 13-17, 2006).</p> <p>(12) Kitchen S.G., C. Jones, E.K. Heyerdahl, M.H. Weber, P.M. Brown, P.J. Weisberg, R.B. Campbell, L.M. Chappell, S. Goodrich, J. Pollet, D.H. Page, T Williams, G. Baker. 2006. "Historic Fire Regimes and Forest Structure in Utah and Eastern Nevada Mountains (poster)." Workshop on Collaborative Watershed Management & Research in the Great Basin, Reno NV (November 28-30, 2006).</p> <p>(13) Brown, P.M. 2007. Multi-proxy, multi-century, and multi-scale fire and forest histories from tree-ring data. Accepted for presentation at the International Association for Landscape Ecology, 22nd Annual Conference in Tucson, AZ (4/9-13/07).</p>	
JFSP Reports	3 progress reports and 1 final report	<p>(1) Heyerdahl_2004_JFSP_summary_form.rtf</p> <p>(2) Heyerdahl_2005_pi_wkshp__summary_form.rtf</p> <p>(3) Heyerdahl_2006 Progress Report.doc and JFSP Project Accomplishment_2006.xls</p> <p>(4) Heyerdahl_JFSP01C-3-3-22_Final_report.pdf</p>

Actively participate in the annual JFSP conference	<p>(1) Heyerdahl, E.K., S.G. Kitchen, P.M. Brown, and M.H. Weber. 2005. "Fire Regimes and Forest Structure of Utah and Nevada: A Multi-scale History from Tree Rings." Joint Fire Sciences Principal Investigator Workshop, San Diego, CA (11/1-11/3/05).</p> <p>(2) Brown, P.M., E.K. Heyerdahl, S.G. Kitchen, and M.H. Weber. 2007. "Climate drivers of fire in Utah." Joint Fire Sciences Principal Investigator Workshop, FL (March 2007).</p>	<p>(1) JFSP_PI_conference_poster_2005.pdf</p> <p>(2) abstract for a poster will be submitted February 2007</p>
Website	www.rmtr.org/Utah/Utahfirehistory.html	Posted in 2004 and updated yearly
Publicly archive data collected	<p>(1) All data on fire and forest history, site characteristics (location, topography, photos, etc.) and associated metadata will be included in the RMRS GTR, which we will publish on DVD.</p> <p>(2) We will archive our fire-scar, tree-recruitment, and associated metadata with the International Multiproxy Paleofire Database (www.ngdc.noaa.gov/paleo/impd/paleofire.html).</p> <p>(3) We are permanently archiving all the wood samples collected for this project. Currently they are stored at Rocky Mountain Research Station and Rocky Mountain Tree-Ring Research, Inc.</p>	<p>(1) We anticipate submitting the GTR in late spring 2007 after we receive feedback from land managers.</p> <p>(2) We will submit this data after our manuscripts have been accepted for publication.</p>

APPENDIX: PROJECT LOCATIONS

state	Land owner	Number of sites		
		full gridded	partial gridded	non-gridded
Utah	Wasatch-Cache National Forest	1		
Utah	Ashley National Forest	3		
Utah	Manti-La Sal National Forest	2		
Utah	Fishlake National Forest	1	2	2
Utah	Dixie National Forest	2		
Utah	Richfield District, Bureau of Land Management	2		
Utah	Vernal District, Bureau of Land Management	1		1
Utah	Moab District, Bureau of Land Management		1	
Nevada	Great Basin National Park	1		
TOTAL		13	3	3