Fire Regimes and Successional Dynamics of Yellow Pine (*Pinus*) Stands in the Central Appalachian Mountains

Final Report to Joint Fire Science Program

Project Number 01C-3-3-09

Principal Investigators

• **Charles W. Lafon,** Department of Geography, Texas A&M University, College Station, TX 77843-3147; Phone: (979) 862-3677; Fax: (979) 862-4487; E-mail: clafon@geog.tamu.edu
• **Henri D. Grissino-Mayer,** Department of Geography, University of Tennessee, Knoxville, TN 37996; Phone: (865) 974-6029; Fax: (865) 974-6025; E-mail: grissino@utk.edu

Federal Cooperators

• **Steven Q. Croy,** George Washington & Jefferson National Forests, 5162 Valleypointe Parkway, Roanoke, VA 24019; Phone: (540) 265-5153; Fax: (540) 265-5145; E-mail: scroy@fs.fed.us
• **Elaine K. Sutherland,** Rocky Mountain Research Station, Forestry Sciences Laboratory, P.O. Box 8089, Missoula, MT 59807; Phone: (406) 542-4169; Fax: (406) 543-2663; E-mail: esutherland@fs.fed.us

Project Synopsis

Introduction

This study used dendroecological (tree-ring) methods to investigate temporal and spatial variations in the fire regimes of xerophytic yellow pine (*Pinus* L.)-dominated stands in the central Appalachian Mountains. Yellow pines occur primarily on dry ridgetops and west- or southwest-facing slopes in the Appalachian Mountains (Williams 1998) (Figure 1). Because of the dissected terrain, the pine stands exist in small patches in a hardwood forest matrix. The pines typically share dominance with oaks (*Quercus* L.), which are the dominant species

Figure 1. Pine stands on the west-facing slopes of Brush Mountain, Virginia. West is toward the right side of the photograph. The dark pine-dominated stands on the west slopes of the spurs alternate with the lighter oak-dominated stands elsewhere.

throughout much of the hardwood forest that forms the matrix cover type. Both pines and oaks are thought to require periodic burning for regeneration and maintenance (Abrams 1992; Williams 1998), but little is known about the fire regimes (fire frequency, seasonality, severity) that characterized the forests prior to the era of effective fire control. The dominant trees have adaptations to stand-replacing fires (e.g., serotinous cones or vigorous sprouting) as well as milder surface burns (e.g., thick bark). Research on prescribed fire effects indicate that both types of fire regimes may benefit these species (e.g., Waldrop et al. 2002), suggesting that fire regimes historically may have varied over time and space.

Table Mountain pine (*P. pungens* Lamb.), in particular, is recognized as a fire-dependent species, and is the focus of considerable attention among resource managers seeking to restore fire-dependent ecosystems (Williams 1998; Waldrop et al. 2002). Table Mountain pine is the most abundant pine in most of the mid-elevation pine stands of the central Appalachians. The species, which has serotinous cones and thick bark, is endemic to the Appalachian Mountains and appears to be declining because of reductions in fire activity that began during the 1930s. To investigate the fire regimes that characterized Table Mountain pine and associated species over the last three centuries, we collected fire-scarred specimens from pine and pine-oak stands distributed over a large section of the central Appalachian Mountains. We also collected forest compositional data and dendroecological age structure data to investigate possible links between fire activity and the establishment of pine and hardwood cohorts. Our research addressed Task 3 of JFSP RFP 2001-3, with the goal of elucidating effects of fire on endemic flora, generating site-specific fire history information, and determining the seasonality of fire. The work has helped fill local knowledge gaps significant to fire management plan development and implementation on lands of the central Appalachian region that are managed by federal, state, and private agencies.

Of particular interest for this project were: (1) the frequency and seasonality of fire in the past, prior to fire control efforts; (2) how fire regimes changed over the course of European settlement, industrialization (timbering and iron mining/smelting), and suppression/prevention; (3) whether pulses of pine and/or oak establishment were associated with the fires that we identified from fire-scarred trees; (4) whether fire-intolerant hardwood trees and shrubs became established during the fire-control era; and (5) how climatic variability influences fire activity.

Study Area

General

We sampled at 10 study sites in the Ridge and Valley and the Blue Ridge physiographic provinces of the Appalachian Mountains, western Virginia (Figure 2). Nine of the sites were on the George Washington and Jefferson National Forests (GWJNFs), and one site was on The Nature Conservancy's (TNC's) Narrows Preserve. Eight of the ten sites were the primary sampling sites, where intensive sampling was conducted for fire-scarred specimens, vegetation composition, and stand age structure (see *Methods*, below). Two of the sites were supplementary sites, where fewer fire-scarred samples were collected, and where no compositional or structural data were obtained. Originally, we had intended to locate a site in the Shenandoah National Park (SNP), which encompasses the Blue Ridge north of Kelly Mountain. However, the retirement of Doug Raeburn, our federal cooperator from SNP, caused us to alter our plans. Another change in project personnel was that Elaine Sutherland assumed a smaller role in this project than originally planned, a result of her duties as Project Leader at the Rocky Mountain Research Station (RMRS) in Missoula, Montana, along with other duties she assumed in research projects in the western U.S. The funding originally proposed for RMRS was directed to PIs Lafon and Grissino-Mayer to compensate for the additional travel, sample preparation, and laboratory analyses for which they became responsible. This reallocation of money was requested by Sutherland on January 29, 2004 and approved by Dr. Bob Clark, Director of JFSP at the time.

Site Descriptions

Primary study sites (RD = Ranger District, JNF = Jefferson National Forest, GWNF = George Washington NF):

(1) Griffith Knob, New River RD, JNF; Drainage basin: New River
(2) Little Walker Mountain, New River RD, JNF; Drainage basin: New River
(3) Peters Mountain, TNC's Narrows Preserve; Drainage basin: New River
(4) Brush Mountain, New River RD, JNF; Drainage basin: James River
(5) North Mountain, Newcastle RD, JNF; Drainage basin: James River
(6) Mill Mountain, Warm Springs RD, GWNF; Drainage basin: James River
(7) Kelly Mountain, Glenwood-Pedlar RD, GWNF; Drainage basin: Shenandoah River
(8) Reddish Knob, Dry River RD, GWNF; Drainage basin: Shenandoah River

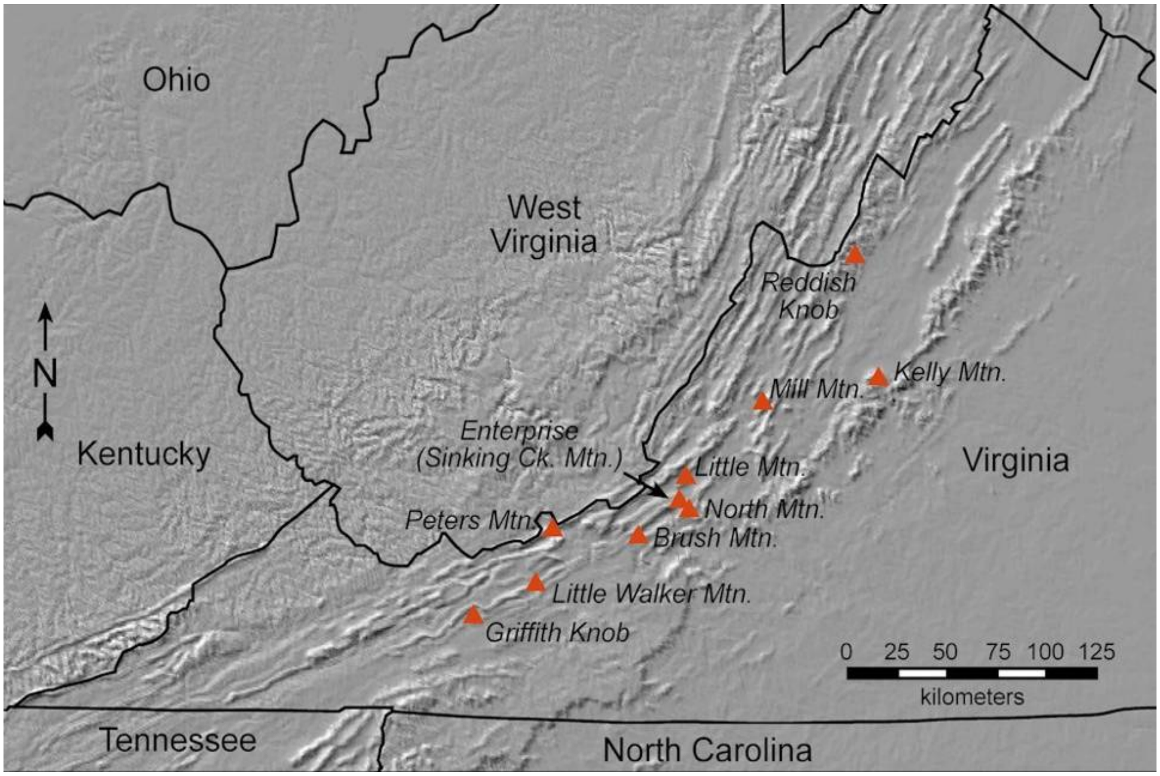

Figure 2. Study sites

Supplementary study sites:

(1) Enterprise (Sinking Creek Mountain), Newcastle RD, JNF; Drainage basin: James River
(2) North Mountain, Newcastle RD, JNF; Drainage basin: James River

The supplementary sites were established in the same drainage basin (the Craig Creek valley of the James River basin) as the two primary sites Brush Mountain and North Mountain. Our intent in nesting this relatively high density of study sites within the larger network was to characterize the historic variability in fire regimes within a small, relatively homogeneous area. One consequence of the high sampling intensity in the Craig Creek valley was that the sites on the JNF were distributed unevenly, with four sites in the Craig Creek valley and one at Griffith Knob. Therefore, Dr. Grissino-Mayer and Ph.D. student Georgina DeWeese obtained a Doctoral Dissertation Research Improvement grant (DDRI) from the National Science Foundation (NSF) to smooth the distribution of sites via establishment of the Little Walker Mountain site.

This research has supported two Ph.D. dissertations (one focused on the JNF sites and the other on the GWNF sites), one M.S. thesis (focused on the TNC preserve), and one B.S. honors thesis (focused on dating pines too small to core).

Methods

Field methods

For each primary study site, we used a chain saw to collect fire-scarred pine specimens from four pine-dominated forest stands. Where possible, we sampled stands from four adjacent spur ridges. However, in some study sites, not all the stands contained sufficient fire-scarred trees, and it was necessary to skip over one or more ridges until we found another stand with a large number of scarred trees. For the two supplementary study sites, fire-scarred samples were collected from a single stand.

The collection protocol was different on TNC's Narrows Preserve at Peters Mountain than on the other sites because of the nature of the study site and the questions of interest. When TNC learned about our Appalachian fire history work, they arranged funding to add Peters Mountain to our fire history network. Peters Mountain is covered primarily by oak forest with a few isolated patches of pine-dominated forest. The oak forests contain scattered pines (Virginia pine – *Pinus virginiana* Mill., pitch pine – *P. rigida* Mill., and Table Mountain pine) that record the fire history of the area. Therefore, we sampled nearly all the fire-scarred pines along the western part of the preserve, in the vicinity of the endemic, fire-dependent herb, Peters Mountain mallow (*Iliamna corei* Sherff.), a species listed as being endangered by the U.S. Fish and Wildlife Service. Despite the differences in environment and sampling strategy on Peters Mountain, we include this site in our report because the work there coincided with our JFSP-funded research and contributes to our regional network of fire history sites.

We cut full or partial cross-sections from living and dead fire-scarred trees, including fallen tree remnants that were solid enough to preserve the tree rings. We collected specimens from > 600 fire-scarred trees, using a GPS unit to mark the locations of the samples. The quality of the sections was higher than anticipated. Despite the humid climate, many of the dead trees contained well-preserved scars dating to the early 1700s. Many individual trees bore multiple fire scars, which facilitated the development of long fire chronologies. The greatest number of fire scars on a single tree was 13 scars on a living pitch pine tree at the Kelly Mountain site.

In three of the four pine stands at each primary study site, a 20 × 50 m plot was established for sampling tree composition and age structure. For each tree with diameter at breast height (DBH) ≥ 5.0 cm, we identified species, measured DBH, and used an increment borer to obtain one to two cores at the base of the tree. We also counted and identified to species all the saplings (DBH < 5.0 cm, height ≥ 50 cm) in the plot. The saplings were too small to core, but branch nodes of the pine saplings were counted to age the trees. The honors thesis of Michelle Pfeffer (University of Tennessee) conducted as part of this project revealed a strong relationship between pine age and number of branch nodes in yellow pines of the central Appalachian Mountains. We further identified and tallied all the tree seedlings (height < 50 cm) within a 20 × 10 m subplot nested within the larger plot. Cross-sections were cut from mountain laurel (*Kalmia latifolia* L.) shrubs to determine the timing of shrub establishment relative to changes in the fire regime. Finally, throughout the 20 × 50 m plot, duff depth was measured at 20 randomly chosen locations. Recent studies have shown that Table Mountain pine regenerates more successfully after fire when duff depth has been reduced to approximately 2–3 cm (Robert Klein, Great Smoky Mountains National Park, *personal communication*).

Because of the hypothesized importance of fire for the widespread oak forests interspersed among the pine stands, Dr. Lafon and Ph.D. student Serena Aldrich expanded the scope of the project by obtaining a NSF DDRI grant for revisiting sites on the GWNF to sample tree composition and age structure of the oak stands. Three additional plots were established in the oak stands at Kelly Mountain and Reddish Knob during Summer 2006. No additional fire history data were obtained because the fires recorded by the pines also would have burned through the intervening oak-dominated forests.

Laboratory methods and analyses

The cores were mounted in standard core mounts, and the cores and cross-sections were sanded with fine-grit sandpaper to reveal the annual rings clearly (Orvis and Grissino-Mayer 2002). The tree rings were crossdated visually, then were measured and crossdated statistically using the computer program COFECHA (Holmes 1986; Grissino-Mayer 2001a). The crossdated tree rings were used to date the fire scars. We determined the seasonality of each fire scar based on the position of the scar within the annual ring (Baisan and Swetnam 1990). Fire dates for each fire-scarred tree were archived and graphed using the FHX2 software (Grissino-Mayer 2001b). FHX2 was also used to analyze the frequency distribution of fire-free intervals. FHX2 fits a Weibull curve to the fire-free interval distribution to model the median fire interval (MEI), lower exceedance interval (LEI), and upper exceedance interval (UEI). The latter two parameters estimate the intervals between which 75% of all fire-free intervals occurred. The tree age and DBH data were used to create age- and size-structure graphs to reveal the timing of tree cohort establishment. The fire-climate analyses have not been completed but will be conducted as part of the ongoing two doctoral dissertations to investigate climatic forcing of region-level fire activity (i.e., did climate synchronize fire activity among the study sites?). However, we have used data on the contemporary fire regime to characterize fire-climate relationships and spatial patterns of wildland fire across the central Appalachian region. The contemporary fire data were obtained from the National Interagency Fire Management Integrated Database (NIFMID) for the period 1970–2003. The NIFMID dataset complements the fire-scar dataset by providing greater detail about the fires (e.g., ignition source, fire size, fire date), albeit for a shorter period. We analyzed NIFMID data for the federal lands of the central Appalachian region, specifically the SNP, GWNF, the northernmost two RDs of the JNF, and the Monongahela National Forest (MNF) (Figure 3).

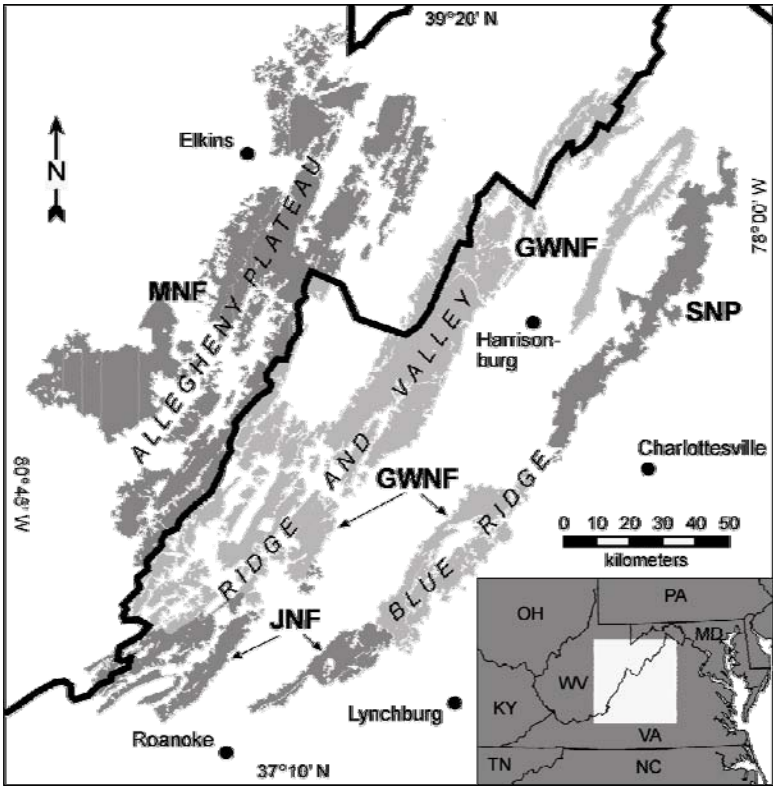

Figure 3. Federal lands in the central Appalachian region for which the contemporary fire regime was analyzed.

We would note here that the project has been more complex and labor-intensive than originally envisioned. Locating fire-scarred pine trees in the densely vegetated Appalachian Mountains is more difficult than in the drier western forests, and requires a considerable amount of time hiking off-trail through dense shrubs and steep terrain. However, once we developed the expertise to find and sample these materials, we found abundant specimens. Because of the large amount of work and the significance of this research for fire science in a region with an understudied fire history, we have supported two Ph.D. dissertations through this JFSP project. Originally we had envisioned that the work would be appropriate for two M.S. theses, but we quickly realized that the project was too extensive for masters research. The Peters Mountain project alone is supporting a M.S. thesis that analyzes > 70 fire-scarred trees and associated plot data.

In this synopsis we report the results to date. Additional analyses are ongoing and will be provided to JFSP later in the form of theses/dissertations and journal articles. One Ph.D. dissertation is nearing completion (Georgina DeWeese, University of Tennessee, degree expected May 2007). The expected completion date for the second Ph.D. dissertation (Serena Aldrich, Texas A&M University) is May 2008. The M.S. thesis for the Peters Mountain site will be completed by December 31, 2006 for a May 2007 graduation (Jennifer Hoss, Texas A&M University). The B.S. honors thesis was completed by Michelle Pfeffer (University of Tennessee) in December 2005.

Results

The trees at Griffith Knob, Brush Mountain, North Mountain, and Mill Mountain recorded fire scars beginning in the early- to middle-1700s (Figures 4–7). The fire history for Peters Mountain begins during the middle-1800s (Figure 8). For the fire charts, each horizontal line represents a single fire-scarred tree, and each vertical hatch mark indicates a dated fire scar. At the bottom of each is the composite fire chart for the site, indicating all the years in which one or more trees recorded a fire. Many of the fires are recorded in multiple pine stands, indicating that the fires were able to burn through the intervening hardwood forests between the neighboring pine stands.

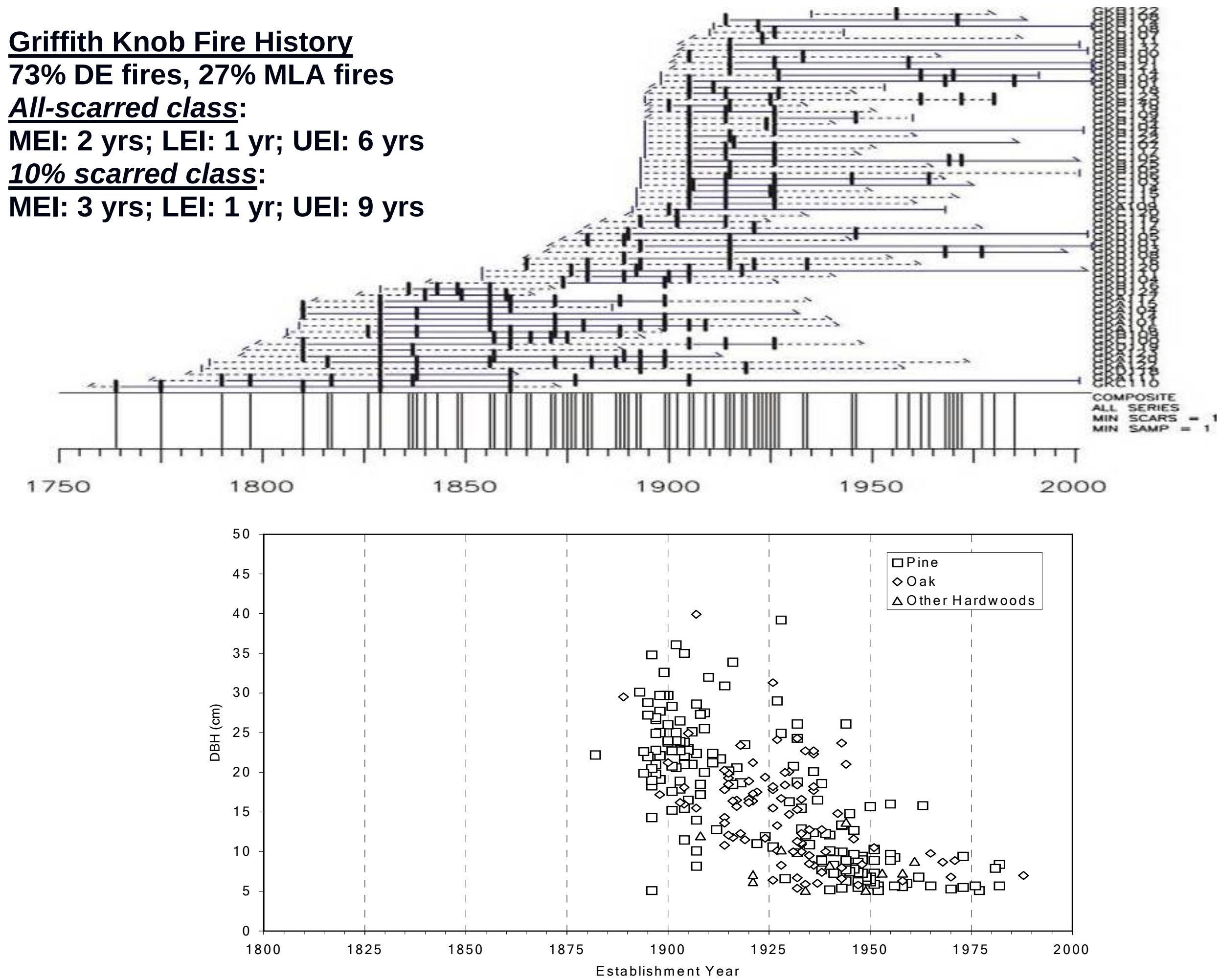

Figure 4. Fire history and age/size structure for the Griffith Knob site.

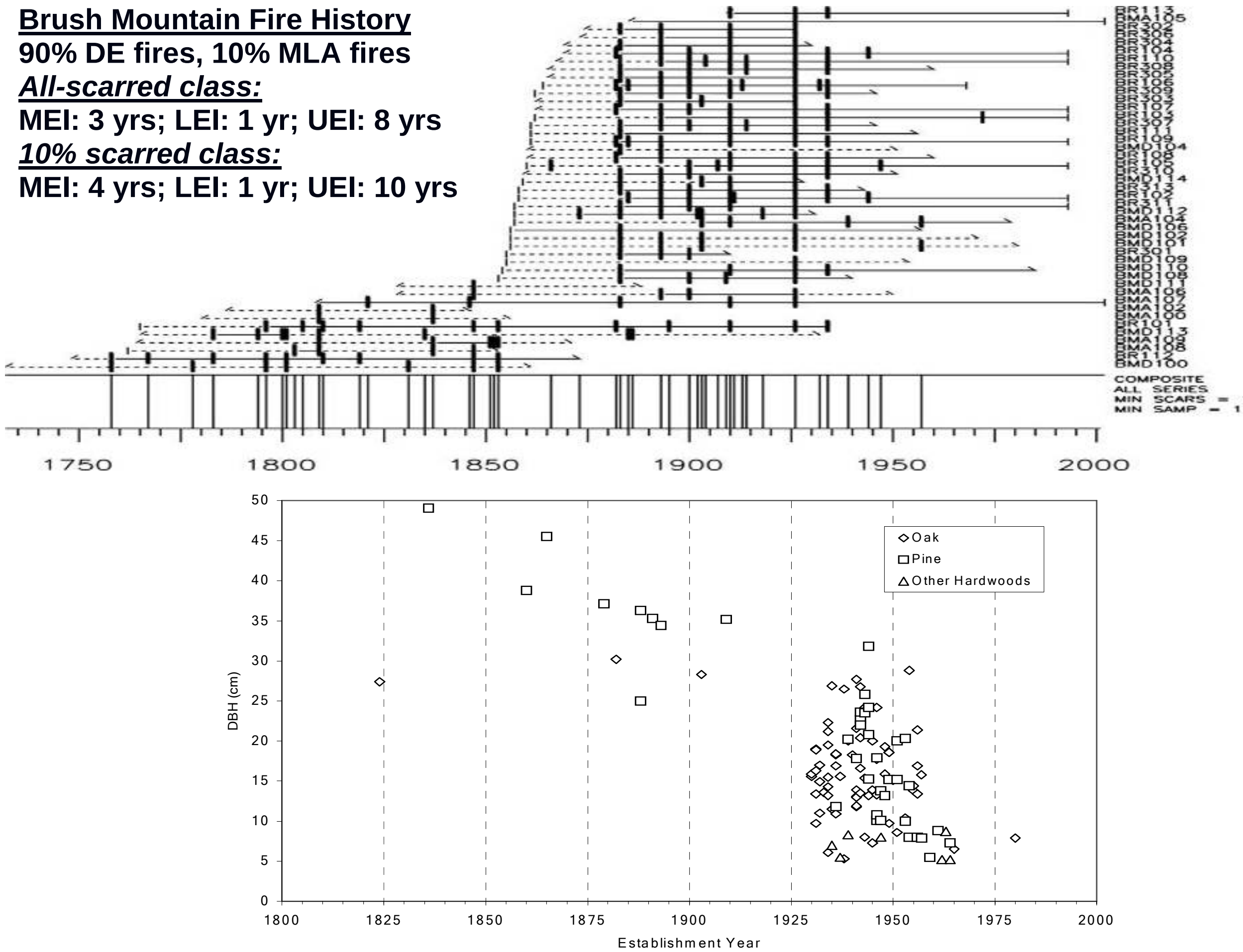

Figure 5. Fire history and age/size structure for the Brush Mountain site.

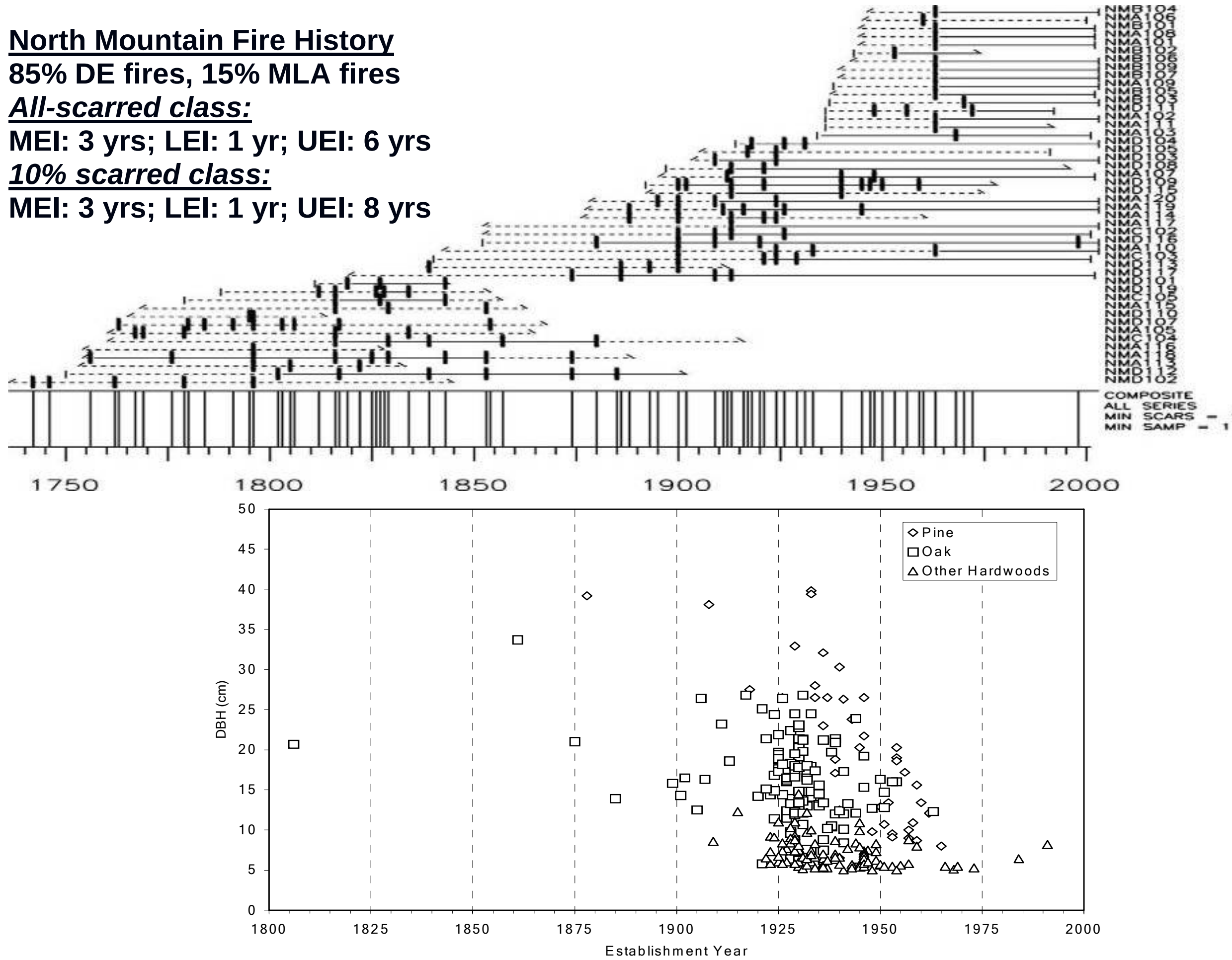

Figure 6. Fire history and age/size structure for the North Mountain site.

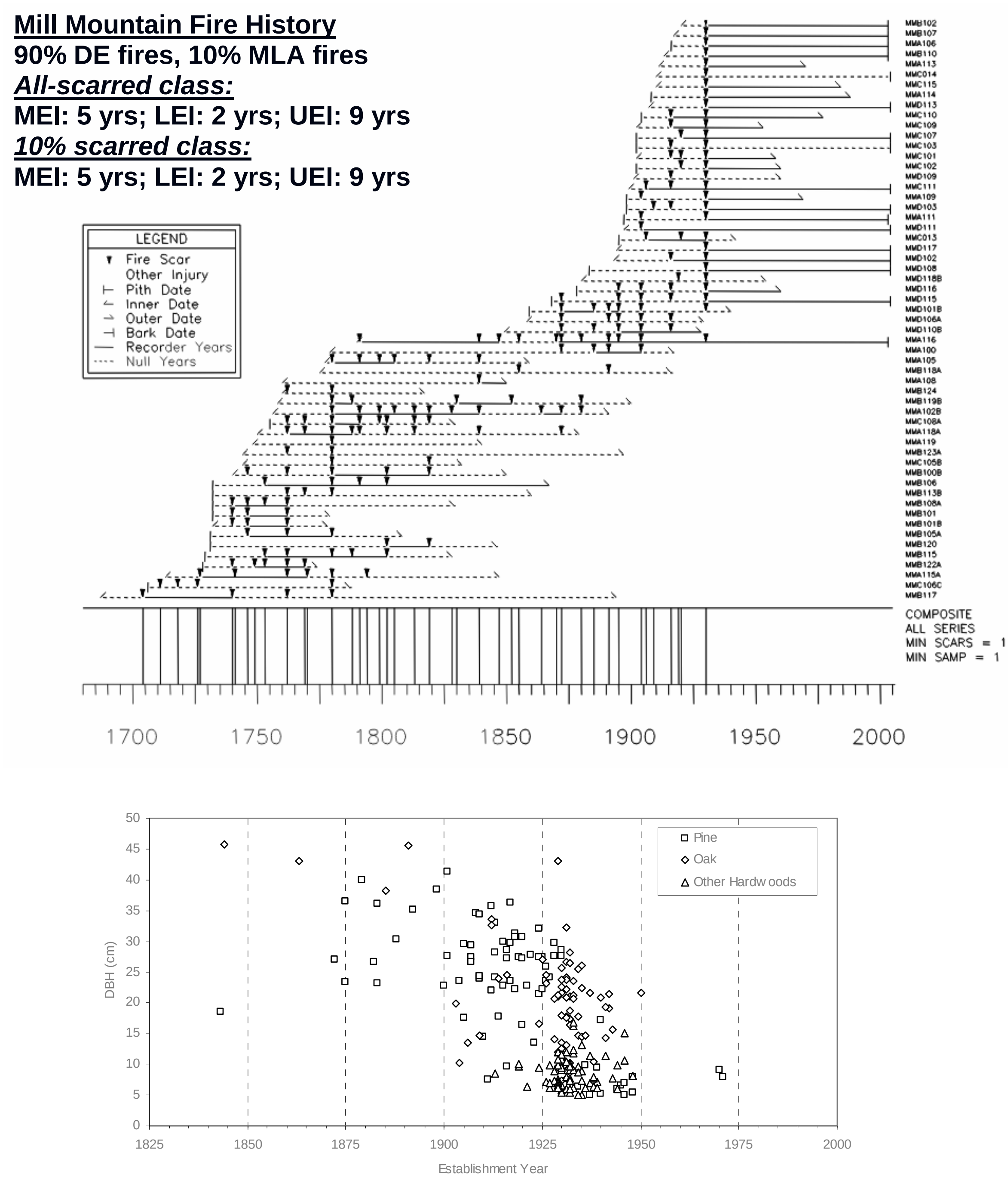

Figure 7. Fire history and age structure for the Mill Mountain site.

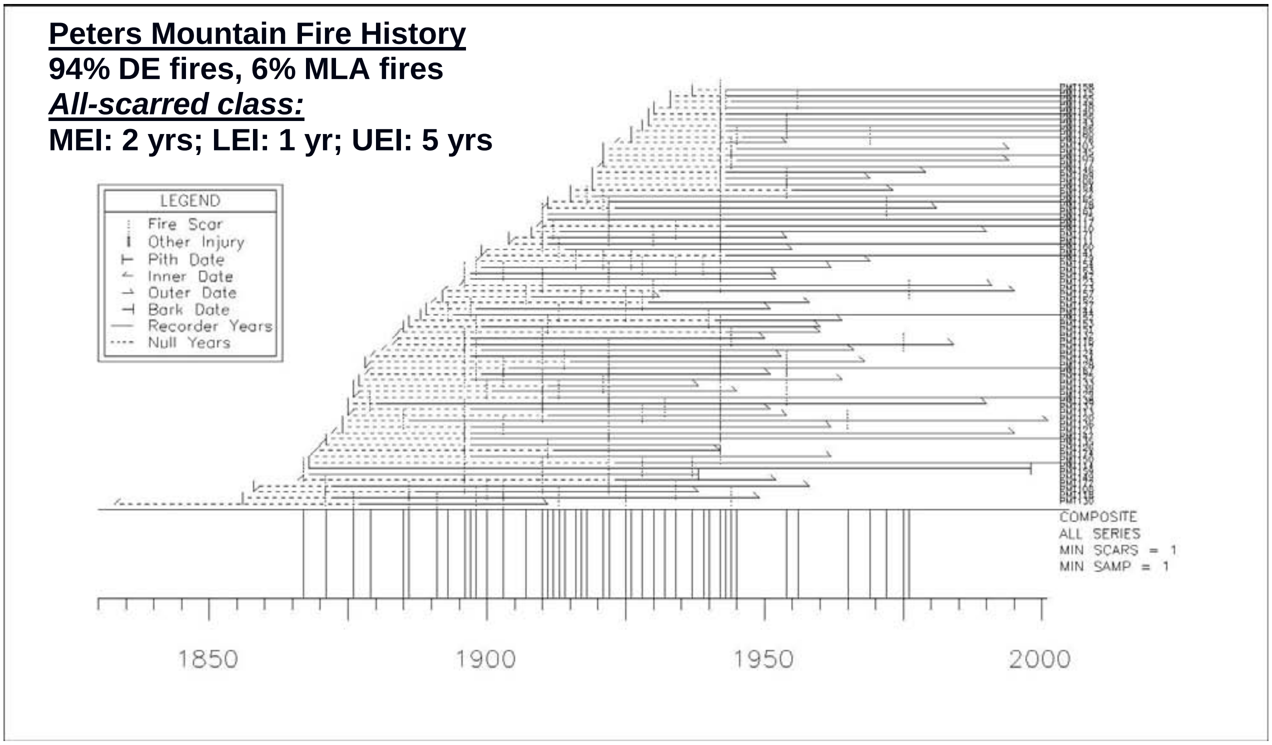

Figure 8. Fire history for the Peters Mountain site.

Fires occurred at 2–5 year intervals at all the sites, as indicated by the MEI reported on each graph. The values under "10% scarred class" indicate the parameters for "major" fires that scarred ≥ 10% of all the trees. Fire activity was lower during the most recent 50–70 years than before. Regarding seasonality, most fire scars were in the dormant season or early-earlywood position (DE), with relatively few in the middle-earlywood, late-earlywood, or latewood (MLA) positions. Examining the fire scars for Mill Mountain indicates that most trees were small when initially scarred. The mean stem diameter at first scarring was 7.4 cm, and the mean age was 19.7 years.

The pine populations contain some distinct age cohorts. These are evident (1) in the relatively synchronous establishment dates of many of the fire-scarred pines and (2) in the age structure graphs for the cored trees. All the sites have more than one pine cohort. In general, most of the pine and hardwood trees that currently inhabit the sites became established within the last 80 years, particularly during the period 1925–1950. The establishment of the mountain laurel shrubs began during the 1940s and peaked during the 1960s and 1970s (Figure 9).

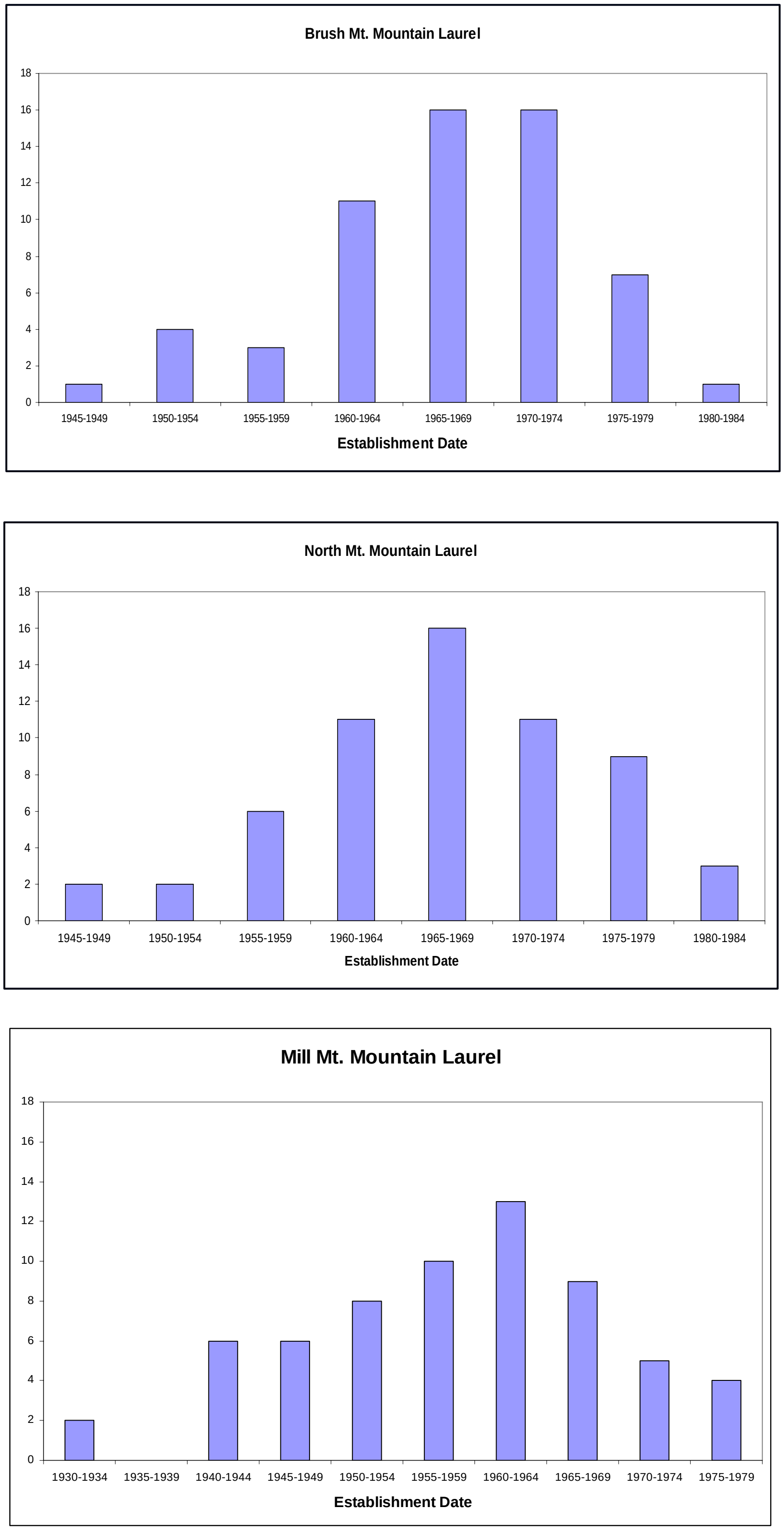

Figure 9. Mountain laurel establishment dates

Analysis of the NIFMID data reveals that on the contemporary Appalachian landscape anthropogenic fires are more common than natural, lightning-ignited burns. The contemporary fire cycle (the time required to burn an area equivalent to the study area; also known as fire rotation period) for the federal lands in the central Appalachian landscape is 1001 years. Anthropogenic fire activity peaks during spring and fall, and most natural fires occur during late spring and early summer (Figure 10). Fire activity is highest during drought years, as indicated by correlations between fire activity and monthly Palmer Drought Severity Index (PDSI) (Figure 11). However, the incidence of fire varies spatially across the central Appalachian region, with greatest fire activity along the Blue Ridge in the eastern portion of the region, a moderate level in the Ridge and Valley in the center, and limited burning on the Appalachian Plateau in the western part of the region (Figure 12).

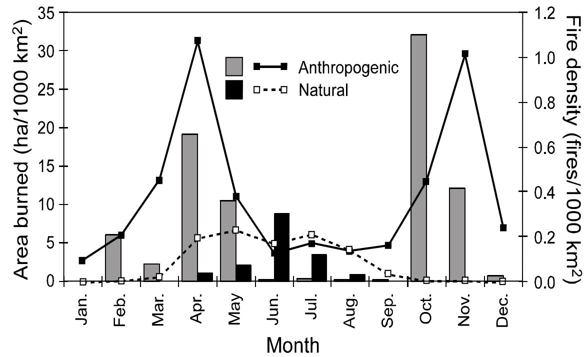

Figure 10. Mean monthly patterns of fire activity during 1970-2003. Bars indicate area burned, and lines indicate ignition density.

Discussion

The fire histories compiled for this project begin during the late presettlement/early settlement period. Settlement is thought to have begun during the late 1700s in the vicinity of most of the study sites. The fire history analyses suggest that the pine and pine-oak stands of the central Appalachian Mountains were characterized by a regime of frequent surface fires prior to fire control efforts. Heavy fuel loads could not have accumulated during the short fire-free intervals, and therefore severe fires probably were uncommon. The small size of the trees at initial scarring provides additional evidence that fires were typically of low severity. Nonetheless, the existence of distinct age cohorts suggests that occasional fires were of higher severity, causing partial stand replacement. The fire regime may be best characterized as mixed severity (cf. Brown 2000). No evidence exists for the occurrence of high severity fires that

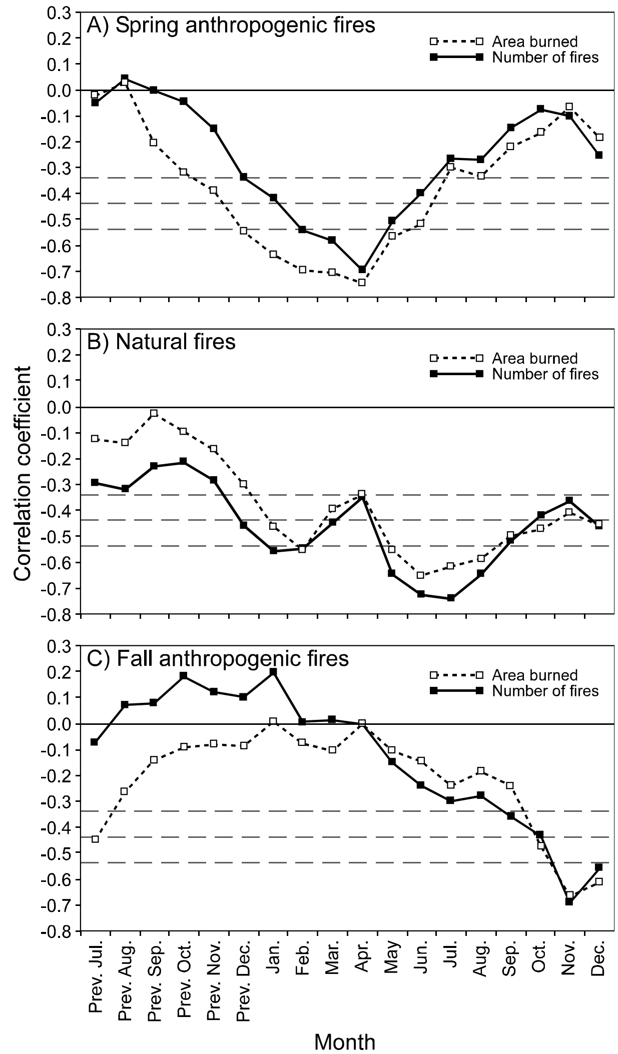

Figure 11. Relationships between monthly PDSI and fire activity for an 18-month period beginning in the previous July and ending in December of the year in question. Horizontal dashed lines indicate critical levels of *r* for *p* <0.05, 0.01, and 0.001.

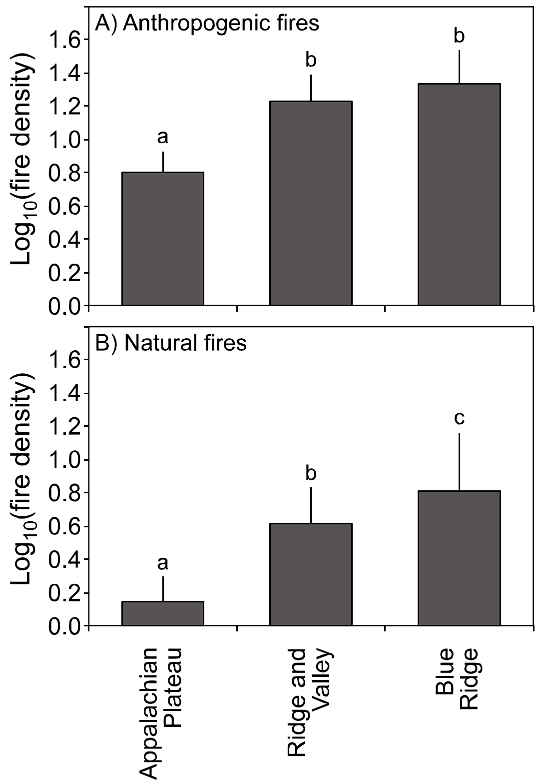

Figure 12. Mean fire density (log-transformed) for all anthropogenic and natural fires in each physiographic province (A, B). Provinces labeled with different letters had significantly different ignition densities according to ANOVA and Tukey tests. The error bars indicate standard deviation.

resulted in complete stand replacement. One important consideration is that forests of eastern North America are subjected to multiple disturbance agents (e.g., ice storms, windstorms, insect outbreaks), and therefore the establishment of some tree cohorts may have been associated with non-fire disturbances or with interacting fire and non-fire disturbances (cf. Lafon and Kutac 2003; Brose and Waldrop 2006).

The preponderance of dormant-season and earlywood scars indicates that most of the fires occurred in the spring or fall, when low humidity, high windspeed, and relatively high temperature favored burning (Lafon et al. 2005). Today, the spring and fall burning seasons are dominated by anthropogenic fires, and this may have been the case in the past. However, lightning ignitions are also common during spring, and may have contributed to a large number of the dormant-season and early-earlywood scars. If the contemporary fire regime is a useful indicator of the past, most of the middle- and late-season scars probably were caused by natural fires. Another pattern indicated by the contemporary fire regime is that both natural and anthropogenic fire activity are greatest during drought years. Whether this was the case in the past is not clear. The high frequency of fires revealed by the fire-scar analyses suggests that fires were common even in non-drought years. We hypothesize that drought years had synchronous fires at multiple study sites throughout the central Appalachian region, but an evaluation of this hypothesis awaits the completion of fire-scar dating for all the study sites.

The decline in fire frequency during the twentieth century most likely reflects successful fire control efforts. Fire activity declined after the 1930s, coincident with the beginning of effective fire prevention/suppression tactics virtually simultaneous with the establishment of the GWJNFs. Most fires that occurred after the 1930s were recorded only on a few trees, probably indicating that either (1) the fires were suppressed quickly, before they could spread throughout the entire study site or (2) the fires were low-severity or patchy fires that were not hot enough to scar most of the trees. At one site, Mill Mountain, the effect of fire control efforts is especially pronounced — no fires were recorded after 1930.

That many of the trees established near the beginning of the fire-control period likely reflects an increase in seedling survival under the altered fire regime. The “other” (non-oak) hardwoods, in particular, were more successful during this period. Presumably, propagules of these species had arrived at the sites previously but had not been able to establish under frequent burning. The “other” hardwood species are mostly fire-intolerant trees such as black gum (*Nyssa sylvatica* Marsh.) and red maple (*Acer rubrum* L.). They were able to survive and establish under the altered fire regime, at least until the stands became too crowded for continued establishment. All the mountain laurels became established following the decline in burning. The age-structure graphs suggest a gradual encroachment of mountain laurel until the 1960s and 1970s, after which increasingly crowded conditions may have inhibited continued shrub expansion. Few pines have established in recent years, nor are pine seedlings abundant. Many of the stands were damaged by an extensive outbreak of the southern pine beetle (*Dendroctonus frontalis* Zimmermann) during the drought of 1998–2002. Without the reintroduction of fire, the pines will continue to decline in abundance and may be replaced by hardwood species. In fact, forest simulation efforts funded by the USDA Forest Service Southern Research Station, but informed by this JFSP project, project a shift from pine to hardwood dominance on dry sites under fire exclusion in the Appalachian Mountains (Lafon et al., in press; Waldron et al., in press).

Another consequence of fire exclusion is a change in fuel loads. Fuel loads appear to be quite high today, and consequently severe burns are possible. The mountain laurels are particularly important because they can serve as ladder fuels. Discussions with fire staff members of the GWJNFs reveal that fires burning through such fuels can be difficult to control and can result in heavy overstory mortality. Such stand-replacing fires appear to have been uncharacteristic of past fire regimes. As pines continue to age and decline in abundance over future decades, surface fuels will become less flammable, because hardwood litter will replace pine litter. Such changes in fuel, combined with a decline in pine seed sources, could contribute to the loss of many of the pine stands. Our results suggest that a critical need exists for resource managers to restore Appalachian pine and pine-oak stands through the use of fire before the window of opportunity is closed. The dominant pine cohorts are aging and will be lost in coming decades. When these seed-producing trees are gone, restoration will be far more difficult. Wildland Fire Use (WFU) may be a viable strategy for increasing fire frequency in some areas, particularly in the largest tracts of federal land along the Blue Ridge, where natural ignitions are most abundant.

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Deliverables

Appendix 1. Crosswalk between proposed and delivered activities and products. The deliverables were described in the original proposal, and at the request of JFSP were expanded via email to Bob Clark on September 17, 2002.

Proposed	Delivered	Status
Annual progress reports	Annual progress reports	Completed
Web pages	Fire Regimes of the Central Appalachian Mountains: http://web.utk.edu/~grissino/jfsp01C3309/default.html	Completed; updated as needed. To be transferred to FRAMES with the help of Greg Gollberg.
Two M.S. theses	Two Ph.D. dissertations, one M.S. thesis, one B.S. honors thesis. See Appendix 2 for list of theses, and enclosed CD for PDF file of completed honors thesis.	Completed: B.S. thesis In progress: Ph.D. and M.S. theses
Peer-reviewed journal articles	One article in print, one article in press, one currently in preparation, several additional articles to be prepared. See Appendix 3 for publication list, and enclosed CD for PDF files of publications to date.	Completed: Papers on contemporary fire regime In progress: Papers on past fire regimes
Paper presentations	Presentations at various conferences, workshops, and universities. See Appendix 4 for list of presentations.	Completed: 27 presentations In progress: additional presentations to be made
Reports in publications accessible to management	Reports summarizing management implications of results	To be submitted after the main peer-reviewed articles are accepted.

Appendix 2. Theses and dissertations associated with the project

Pfeffer, Michelle. 2005. Regression-based age estimates of yellow pine (*Pinus*) saplings, Jefferson National Forest, Virginia. Bachelor's Honors Thesis, Department of Geography, The University of Tennessee, Knoxville. 58 pp.

Hoss, Jennifer A. 2007 (expected). Fire history and forest stand dynamics of the Narrows Preserve, Peters Mountain, Virginia. M.S. Thesis, Department of Geography, Texas A&M University, College Station, in progress.

DeWeese, Georgina G. 2007 (expected). Range of variability in fire regimes of Table Mountain Pine (*Pinus pungens* Lamb.) stands, Jefferson National Forest, Virginia. Ph.D. Dissertation, Department of Geography, University of Tennessee, Knoxville, in progress.

Aldrich, Serena R. 2008 (expected). Fire regimes and successional dynamics of central Appalachian yellow pine forests. Ph.D. Dissertation, Department of Geography, Texas A&M University, College Station, in progress.

Appendix 3. Publications associated with the project

Lafon, Charles W., Jennifer A. Hoss, and Henri D. Grissino-Mayer. 2005. The contemporary fire regime of the central Appalachian Mountains and its relation to climate. *Physical Geography* 26:126–146.

Lafon, Charles W. and Henri D. Grissino-Mayer. 2006. Spatial patterns of fire occurrence in the central Appalachian Mountains and implications for wildland fire management. *Physical Geography*, in press.

DeWeese, Georgina G., Henri D. Grissino-Mayer, and Charles W. Lafon. Evaluating the dendrochronological potential of central Appalachian Table Mountain pine (P*inus pungens* Lamb.). Manuscript in preparation.

Aldrich, Serena R., Charles W. Lafon, Henri D. Grissino-Mayer, and Jennifer A. Hoss. Three centuries of fire and stand development in *Pinus pungens* stands on a central Appalachian landscape. Manuscript in preparation.

Appendix 4. Research presentations associated with the project

Invited presentations

Charles W. Lafon, Henri D. Grissino-Mayer, Elaine K. Sutherland, Steve Q. Croy, Georgina D. Wight, and Serena R. Aldrich, 2003. Fire regimes and successional dynamics of yellow pine (*Pinus*) stands in the central Appalachian Mountains. George Washington and Jefferson National Forests, **Fire Management Officers and Rangers Meeting**, 14–17 October 2003, Marion, Virginia.

Charles W. Lafon, 2003. Forest disturbances in the Appalachian Mountains: Patterns and consequences. **Department of Geography, Emory & Henry College,** November 2003, Emory, Virginia.

Charles W. Lafon, Henri D. Grissino-Mayer, Elaine K. Sutherland, Steven Q. Croy, Georgina D. Wight, and Serena R. Aldrich, 2004. Fire regimes and successional dynamics of yellow pine (*Pinus*) stands in the central Appalachian Mountains. **Region Eight Joint Fire Management Officers and Integrated Resources Meeting**, 20–23 January 2004, Savannah, Georgia.

Charles W. Lafon, 2004. Ice and fire: Patterns and consequences of forest disturbances in the Appalachian Mountains. **Department of Earth Environmental Science, Columbia University,** April 2004, Palisades, New York.

Charles W. Lafon, Henri D. Grissino-Mayer, Georgina DeWeese Wight, Serena R. Aldrich, Steven Q. Croy, Elaine Kennedy Sutherland, and Michelle Pfeffer, 2004. Range of variability in fire regimes of Table Mountain pine (*Pinus pungens* Lamb.) stands in Virginia. George Washington and Jefferson National Forests, **Fire Management Officers and Rangers Meeting**, 12–14 October 2004, Marion, Virginia.

Charles W. Lafon, Georgina G. DeWeese, Henri D. Grissino-Mayer, Serena R. Aldrich, Steven Q. Croy, and Elaine Kennedy Sutherland, 2005. Fire history and forest succession in yellow pine stands of the Appalachian Mountains. **Southern Appalachian Fire Ecology Symposium**, 24–25 May 2005, Coweeta Hydrological Station, Franklin, North Carolina.

Charles W. Lafon, Henri D. Grissino-Mayer, Georgina DeWeese Wight, Serena R. Aldrich, Jennifer A. Hoss, and Steven Q. Croy, 2006. Fire history and forest succession in the central Appalachian Mountains. **Ecological Fire Management Objective Setting Workshop**, The Nature Conservancy, 5-6 February 2006, Warm Springs, Virginia.

Conference presentations

Carol L. Hardy, Henri D. Grissino-Mayer, and Charles W. Lafon, 2004. The history of fire in the mountains of western Virginia: Ongoing research and implications in wildlife management. Annual Meeting, **Virginia Chapter of the Wildlife Society**, 18–20 February 2004, Richmond, Virginia.

Georgina DeWeese Wight, Henri D. Grissino-Mayer, Charles W. Lafon, and Elaine Kennedy Sutherland, 2004. Spatiotemporal analyses of fire regimes in yellow pine stands, Craig Creek Valley, Virginia, USA. Annual Meeting, **Association of American Geographers**, 14–19 March 2004, Philadelphia, Pennsylvania.

Charles W. Lafon, Jennifer A. Hoss, and Henri D. Grissino-Mayer, 2004. Temporal patterns of wildfire and their relations to climate in the central Appalachian Mountains. Annual Meeting, **Southwestern Division of the Association of American Geographers**, 11–13 November 2004, Nacogdoches, Texas.

Georgina DeWeese Wight, Henri D. Grissino-Mayer, Serena R. Aldrich, Charles W. Lafon, Steven Q. Croy, and Elaine Kennedy Sutherland, 2004. Fire regimes and successional dynamics of Appalachian yellow pine (*Pinus*) stands in the Jefferson National Forest, Virginia. Annual Meeting, **Southern Appalachian Man and the Biosphere**, 16–18 November 2004, Gatlinburg, Tennessee.

Georgina DeWeese Wight, Henri D. Grissino-Mayer, Serena R. Aldrich, Charles W. Lafon, Steven Q. Croy, and Elaine Kennedy Sutherland, 2005. Variability of fire regimes and stand structure in yellow pine (*Pinus*) stands, Jefferson National Forest, Virginia. Annual Meeting, **Association of American Geographers**, 5–9 April 2005, Denver, Colorado.

Serena R. Aldrich, Charles W. Lafon, Georgina DeWeese Wight, Henri D. Grissino-Mayer, Steven Q. Croy, and Elaine Kennedy Sutherland, 2005. "Our pappies ain't burnin' the woods no more": The changing fire regimes of Table Mountain pine stands on Mill Mountain, Virginia. Annual Meeting, **Association of American Geographers**, 5–9 April 2005, Denver, Colorado.

Michelle Pfeffer, Georgina DeWeese Wight, Henri D. Grissino-Mayer, and Charles W. Lafon, 2005. Regression-based age estimates of yellow pine (*Pinus*) saplings, Jefferson National Forest, Virginia. Annual Meeting, **Association of American Geographers**, 5–9 April 2005, Denver, Colorado.

Henri D. Grissino-Mayer, Charles W. Lafon, and Georgina DeWeese Wight, 2005. Fire regimes and successional dynamics of yellow pine (*Pinus*) stands in the central Appalachian Mountains. Annual Meeting, **Joint Fire Science Program**, 1–3 November 2005, San Diego, California.

Jennifer A. Hoss, Charles W. Lafon, Henri D. Grissino-Mayer, and Georgina D. Wight, 2005. Stand dynamics of Peters Mountain, Giles County, Virginia. Annual meeting of the **Southwestern Division of the Association of American Geographers**, 9–12 November, Fayetteville, Arkansas.

Georgina D. Wight, Henri D. Grissino-Mayer, and Charles W. Lafon, 2006. Dendrochronology and forest ecology. **Rx310 Conference, Introduction to Fire Effects**. 30 January-3 February 2006, Pigeon Forge, Tennessee.

Georgina DeWeese Wight, Henri D. Grissino-Mayer, Serena R. Aldrich, Charles W. Lafon, Steve Croy, and Elaine Kennedy Sutherland, 2006. Fire regimes, stand dynamics, and climate response in three pine stands of the Jefferson National Forest, central Appalachian Mountains, Virginia. Annual Meeting, **Association of American Geographers**, 7–11 March 2006, Chicago, Illinois.

Serena R. Aldrich, Charles W. Lafon, Henri D. Grissino-Mayer, and Georgina D. Wight, 2006. Fire history and stand dynamics of Table Mountain pine forests on Mill Mountain, Virginia. Annual Meeting, **Association of American Geographers**, 7–11 March 2006, Chicago, Illinois.

Jennifer A. Hoss, Charles W. Lafon, Henri D. Grissino-Mayer, and Georgina D. Wight, 2006. Rekindling the flame: Reconstructing a fire history for Peters Mountain, Giles County, Virginia. Annual Meeting, A**ssociation of American Geographers**, 7–11 March 2006, Chicago, Illinois.

Charles W. Lafon, Jennifer A. Hoss, and Henri D. Grissino-Mayer, 2006. The contemporary fire regime of the central Appalachian Mountains: Fire characteristics, climatic relationships, and spatial variations. Annual Meeting, **Association of American Geographers**, 7–11 March 2006, Chicago, Illinois.

Michelle Pfeffer, Georgina DeWeese Wight, and Henri D. Grissino-Mayer, 2006. Saving the forest family: Regression-based age estimates of Table Mountain pine saplings. **Exhibition of Undergraduate Research and Creative Achievement**, 30–31 March 2006, The University of Tennessee, Knoxville, Tennessee.

Henri D. Grissino-Mayer, Charles W. Lafon, Georgina G. DeWeese, Serena R. Aldrich, Elaine K. Sutherland, and Steven Q. Croy, 2006. Dendroecological reconstructions of fire regimes for the central Appalachian Mountains, USA. **Seventh International Conference on Dendrochronology**, 11–17 June 2006, Beijing, China.

Georgina G. DeWeese, Henri D. Grissino-Mayer, and Charles W. Lafon. 2006. Fire Ecology in the Mountains: Forest Dynamics and Disturbance Regimes of Southeastern Mixed Hardwood-Conifer Forests. **Prescribed Fire Workshop, USDA Forest Service,** 16–20 October 2006, Johnson City, Tennessee.

Jennifer A. Hoss, Charles W. Lafon, Henri D. Grissino-Mayer, and Georgina G. DeWeese, 2006. Rekindling the flame: Reconstructing a fire history for Peters Mountain, Giles County, Virginia. **Southwestern Division of the Association of American Geographers**, 26–28 October 2006, Norman, Oklahoma.

Charles W. Lafon and Henri D. Grissino-Mayer, 2006. The contemporary fire regime of the Central Appalachian Mountains: Spatial and temporal patterns of fire. **Third International Fire Ecology and Management Congress**, 13–17 November 2006, San Diego, California.

Henri D. Grissino-Mayer, Charles W. Lafon, Georgina G. DeWeese, Serena R. Aldrich, Elaine K. Sutherland, and Steven Q. Croy, 2006. Reconstructed fire regimes of the Central Appalachian Mountains using a nested-layer network of dendroecological sites. **Third**

International Fire Ecology and Management Congress, 13–17 November 2006, San Diego, California.

Charles W. Lafon, Henri D. Grissino-Mayer, Georgina G. DeWeese, Serena R. Aldrich, Jennifer A. Hoss, Elaine K. Sutherland, and Steven Q. Croy. 2007. Fire history and vegetation change in a network of pine-oak stands in the central Appalachian Mountains. **Second Fire Behavior and Fuels Conference**, 26–30 March 2007, Destin, Florida.

Charles W. Lafon, Jennifer A. Hoss, Henri D. Grissino-Mayer, and Georgina DeWeese, 2007. Fire history and forest stand dynamics of the Narrows Preserve, Peters Mountain, Virginia. Annual Meeting, **Association of American Geographers**, 17–21 April 2007, San Francisco, California.