Final Report

JFSP Project 01-3-3-04

Fire and oak regeneration in the southern Appalachians

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Summary of research objectives accomplished.

The work conducted under this JFSP project largely met with the research and technology transfer objectives outlined in the proposal as follows:

1. We established research sites on the Morehead District of the Daniel Boone National Forest during the spring of 2002, with 92 permanently marked research plots in 9 treatment areas (3 controls, 3 'frequent' burns, and 3 'infrequent' burns);
2. 'Frequent' and 'infrequent' burn treatments were burned sites in 2003 and 2004;
3. Fire effects on stand structure, light environment, seedling performance, fuel accumulation and reduction, scorch height, individual tree response, and a suite of other effects were measured;
4. Data were analyzed and reported in two M.S. theses, and are being used in our current JFSP-funded research in which we are building on the findings described below.
5. Technology transfer objectives were mostly fulfilled, particularly those objectives related to enhancement of communication among researchers and managers. Several new objectives were added to the research as a result of technology transfer activities.

With this funding we initiated a new study and continued to monitor a long-term seedling population study. The key finding from the long-term seedling population study was that after 5 years of periodic prescribed fire, red maple seedlings experienced higher mortality than oak seedlings, yet showed larger growth responses. Canopy cover was temporarily reduced following burning, but the leaf area removed was essentially replaced, lower down, with leaves on stump sprouts from stems damaged or killed by fire.

The initial effects of prescribed fire in the new study (on terrain that is much more varied) were reduced understory stem density and basal area and increased basal sprouts. Canopy cover was temporarily reduced, but returned to pre-treatment levels within one year. Sassafras seedlings had the highest survival among the species present, followed by *Erythrobalanus* oak species, *Leucobalanus* oak species, and finally, maples. A repeated measures split-plot design was used to detect differences in fuels by treatment (burned or unburned), sampling time (preburn, postburn, and 10 months postburn), and landscape position (mesic, intermediate, or xeric). Large woody fuel mass (>7.6 cm diameter) and the Oea layer of the forest floor differ by landscape position, with more Oea on xeric positions and more large woody fuels on mesic positions. Litter (Oi) and small 1-hour woody fuels were reduced postburn, but did not differ from preburn fuel loads 10-months postburn. Using regression modeling, nine variables and four interaction terms including species, DBH, and landscape position, were found to influence maximum bark scorch height on trees >2 cm DBH.

Project deliverables.

Deliverables for the project are listed below (in italics) with a statement following each one describing how the deliverables match what was actually produced. The deliverables are organized in three categories; knowledge-based deliverables described in the proposal (A), additional deliverables resulting from the proposal review process (B), and technology transfer deliverables (C).

A. The following knowledge-based deliverables were described for this project (in italics), and have been fulfilled as described below:

Landscape-scale study

1. *Characterization of the structural and consequent light regime changes, and range of conditions, created by single and repeated (2x) fire on varying site classes.*

This was addressed through repeated measures of permanently marked trees in 92 forest plots. Changes in the light environment were quantified using hemispherical photography and densiometers. Findings are reported in Green (2005).

2. *An assessment of the response of oak regeneration to the range of light conditions created by single and repeated (2x) fire.*

Response of oak regeneration was quantified primarily in the context of landscape position and fire treatment. Findings are reported in Green (2005).

3. *Seedling recruitment, focusing on oak and maple, in response to the range of light conditions created by fire treatments.*

Seedling recruitment was measured in 2 small subplots located in each of the 92 experimental plots. Data on seedling recruitment are stored for later analysis.

4. *An assessment of future expected seedling/sapling basal diameter and height growth, as well as projections of post-release success of oak regeneration.*

Data were collected prior to and following prescribed burning for application in a model that projects changes in oak regeneration potential. Modeling activities are ongoing.

Existing seedling population study

1. *Assessment of oak and red maple seedling response to light conditions created by single and repeated fire on xeric sites.*
2. *Six-year survival of oak and red maple seedlings following varied burn regimes.*

These two objectives were the focus of one chapter of Green's thesis, and a paper is in preparation describing the results of this work.

B. An additional deliverable was added to the project following project review and two additional goals for the project were added following the first meeting with the Daniel Boone National Forest Management Team.

Two M.S. Theses resulting from work conducted by two M.S. students supported by the project were added as deliverables.

The theses supported by and completed during this project are:

Green, Stephanie. 2005. The effects of prescribed fire on stand structure, canopy cover and seedling populations in oak dominated forests on the Cumberland Plateau, KY.

Loucks, Elizabeth. 2004. The effects of landscape scale prescribed fire on fuel loading and tree health in an Appalachian hardwood forest, Kentucky.

As a result of input from forest managers, we added two objectives as follows:

1. *Quantification of woody fuels and litter before and after prescribed burning.*
2. *Assessment of the effects of fire on residual (overstory) stems, including scorch height, scarring, and crown health class.*

These two objectives were addressed by Loucks (2004).

C. We described a suite of technology transfer deliverables for the project.

Within the Daniel Boone National Forest, and generally in the region, there is increasing acceptance for and use of fire, yet documentation of the effectiveness of fire in accomplishing management goals lags behind. The technology transfer components of the JFSP 2001-3 funding were designed to develop strategies to facilitate communication among researchers and managers.

We proposed several approaches to accomplish the twin goals of having managers and researchers working together more closely, and contributing to the regional dialogue.

1. <u>DBNF Management team meetings</u>

Approach: To heighten the level of interaction and synergy between management and research activities, M. Arthur will attend DBNF Management Team Meetings on an annual basis for the duration of the grant. Previous research activities have not been directly disseminated to forest managers beyond those directly involved in fire management decisions and research activities. This approach will also improve communication of management needs for further development of research activities.

Schedule – Spring/summer 2002, 2003, and 2004.

Audience – DBNF District Rangers, Forest Staff Officers, and Forest Supervisor.

M. Arthur attended DBNF Management Team Meetings to address this objective. This resulted in the inclusion of data acquisition activities which weren't part of the project proposal, but which managers saw as being essential to management concerns regarding the use of fire. There were two areas of research that were added to the project: tree health monitoring and fuels inventories. The tree health monitoring component of the project included recording the canopy status of all trees >10 cm DBH in our plots, the presence and size of all previous fire scars or other wounds on the bottom 5 m of the bole, and scorch heights after burning. The fuels inventory included pre- and post-burn quantification of woody fuels and litter, as well as the fuel accumulation around individual canopy trees. The results of these research activities are detailed in Loucks (2004).

2. <u>Annual summary of research activities and site visits</u>

Approach: On an annual basis, starting in spring 2002 and continuing for the duration of the funding period, project leaders will summarize research activities and findings for Forest Service managers. This summary approach acknowledges that peer-reviewed publications are not necessarily the best format for communicating research results to managers, and that discussion and field visits can be far more productive, both for facilitating technology transfer and to ensure that research is responsive to management needs.

Research activities and findings have been summarized for Forest Service managers on two occasions, and incorporated site visits. Input from FS managers, including concerns about negatively perceived fire effects, were incorporated into ongoing discussions about the

timeline for repeated burning, as well as the inclusion of additional measurements. As a result of one of these meetings we spent several weeks quantifying the exposure of mineral soil in burned and unburned sites. This information helped to determine that annual burning was not feasible, and as a result we lengthened the fire return interval for sites burned both 'frequently' and 'infrequently'.

3. Fire and fire effects booklet for lay audience

Approach - We will synthesize the existing knowledge base regarding fire and its effects in oak-dominated forests in the region in a booklet written and designed for the lay audience. We will pattern this effort after a highly successful booklet written collaboratively by researchers and managers (Forests, Forest Fires and Their Makers, 1999). The purpose of this booklet will be to inform the interested lay person of fire management activities, goals and effects.

For this 'deliverable' we obtained a no-cost extension on the project. This brochure is now in the final stages of production, and an electronic (draft) version of the brochure is included in this report.

4. Field trip for diversity of stakeholders

Approach - We will sponsor a field trip to the research sites to cultivate communication among managers, researchers and other stakeholders to promote a synergistic approach to management and research pursuits.

We were not successful in sponsoring this field trip for stakeholders. The period of this project was overshadowed by the long-term development of the Daniel Boone National Forest Management Plan and all the attendant pressures.

5. Annual Dean's Tour

Approach: There is an annual tour conducted in alternate years by the University of Tennessee and the University of Kentucky Forestry departments. This "Annual Dean's Tour" draws together the Deans of the two universities' agriculture colleges, along with personnel from the Kentucky and Tennessee state forestry agencies, Daniel Boone and Cherokee National Forests, and other interested parties, which in the past have included forest industry representatives, environmentalists, and wildlife enthusiasts. The University of Kentucky will plan and organize this event in 2003 that focuses on the research goals and results from this project. Dr. Donald Graves, UK Forestry Chair, has made a verbal commitment to M. Arthur to focus the 2003 Dean's Tour on this topic.

This intended deliverable did not materialize because the University of Kentucky, Department of Forestry was in the process of a protracted search for a departmental Chair for the duration of this project, and there has been no annual Dean's Tour since 2001.

Although two of our five technology transfer deliverables were not completed, we were very successful in addressing the general goal of establishing, nurturing and addressing management concerns relating to the use of prescribed fire in the Daniel Boone National Forest and in the broader geographical region. In particular, the interchange among researchers and managers of ideas and concerns relating to prescribed fire resulted in excellent and ongoing dialogue, as well as several additional aspects of the study (fuels and health of residual trees).

List of research and technology transfer 'products.'

1. M.S. Theses (electronic copies provided):

Green, Stephanie. 2005. The effects of prescribed fire on stand structure, canopy cover and seedling populations in oak dominated forests on the Cumberland Plateau, KY.

Loucks, Elizabeth. 2004. The effects of landscape scale prescribed fire on fuel loading and tree health in an Appalachian hardwood forest, Kentucky.

2. Website for this JFSP project and a current project, combined together at:
http://www.fs.fed.us/r8/boone/fire/fsa/team.shtml

3. Fire and fire effects booklet (electronic copy provided).

4. Research papers in preparation, intended for peer-reviewed journals as noted:

Blankenship, B.A. and M.A. Arthur. In preparation. Stand structure over eight years in burned and fire-excluded oak stands on the Cumberland Plateau, Kentucky. Intended for Forest Ecology and Management. Expected submission August 2005.

Loucks, E., M.A. Arthur and D. Loftis. In preparation. Characterization and reduction of fuel after a single prescribed fire in an Appalachian hardwood forest, Kentucky. Forest Ecology and Management. Expected submission September 2005.

Green, S.R., M.A. Arthur and B.A. Blankenship. In preparation. The effects of periodic prescribed fire on oak (Quercus spp.) and red maple (Acer rubrum) seedlings on xeric ridgetops in eastern Kentucky. Journal of the Torrey Botanical Society. Expected submission October 2005.

Loucks, E., M.A. Arthur and D. Loftis. In preparation. Characterization and predictors of maximum bark scorch height and tree mortality after a single prescribed fire in a eastern hardwood forest, Kentucky. Southern Journal of Applied Forestry. Expected submission October 2005.