



# ***Fire Effects/Fire Ecology Annual Report***

***Southern Appalachian/Piedmont Fire Effects Monitoring Team***

***Calendar Year 2012***



*“Examine each question in terms of what is ethically and esthetically right, as well as what is economically expedient. A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.”*

*-- Aldo Leopold, from **The Land Ethic***

**Pictures (clockwise from top left)**

***Thermopsis mollis (Allegheny golden banner) – this rare legume was observed April 1, 2012 blooming in profusion in the Saddleback burn unit at Kings Mountain National Military Park. This area has been burned three times.***

***A twice-burned Chestnut oak forest in the Divide Road burn unit at Big South Fork NRRRA provides an image of an oak woodland restoration in progress – this was the first test plot at BISO for a new Fire Effects Mapping Protocol.***

***Lilium michauxii (Carolina lily) – this spectacular wildflower is an infrequent inhabitant of pine –oak forests in Great Smoky Mountains N.P. This plant is blooming on the site of a 2009 wildfire near the popular Laurel Falls Trail.***

***Smoke and flames from the first prescribed burn in nearly two decades at Cape Hatteras National Seashore frame the Bodie Island Lighthouse. This was the first of two large-scale burns at CAHA in 2012.***

***Biologists from Cape Hatteras N.S., Shenandoah N.P, Great Smoky Mountains N.P. and the Southeast Region Fire Office met at CAHA in October 2012 to develop and establish a long-term fire effects monitoring program.***

***The Gobblers Knob prescribed burn was a great second-entry into a large landscape that is being managed with fire by Big South Fork NRRRA. This burn was led by the Cumberland Gap Wildland Fire Module and could not have been done without help from Fire professionals from several Southeast Region parks.***

## A. Introduction

The Southern Appalachian/Piedmont fire effects/fire ecology team provided monitoring support for nine NPS units in the Southeast Region during 2012, including a significant program start-up effort at Cape Hatteras National Seashore (**Table 1**). Vegetation complexity and travel distance necessitated the development of a new monitoring protocol for the Seashore, and that new approach is described in the Cape Hatteras section of this annual report. Other achievements included completion of a large monitoring project at Congaree N.P., and development and testing of a new protocol that is tied to burn severity mapping (dNBR). This new protocol can serve as a supplement or alternative to the traditional FMH plot protocols, and is described in the BISO and GRSM sections of this annual report.

**Table 1. Fire Effects Plot Workload (2012) and Total Plots Installed**

| Park                         | Monitoring Unit           | Plot Type                         | Pre-burn 2012 | Immed Post 2012 | Postburn (1-20 yr) 2012 | Annual Total (2012) | Total Plots |
|------------------------------|---------------------------|-----------------------------------|---------------|-----------------|-------------------------|---------------------|-------------|
| Big South Fork (BISO)        | Fuels Transects           | Fuel Transect                     | 4             | 4               | 4                       | 12                  | 4           |
|                              | Little Bluestem           | FMH Forest Plot                   |               |                 | 2                       | 2                   | 4           |
|                              | White Oak/ Shortleaf Pine | FMH Forest Plot                   |               |                 | 6                       | 6                   | 15          |
|                              | Alternative Monitoring    | CBI + Species Composition         |               |                 | 5                       | 5                   | 5           |
|                              | CBI                       | CBI                               |               |                 |                         | 0                   | 9           |
| Blue Ridge (BLRI)            | Chestnut Oak              | FMH Forest Plot                   |               |                 |                         | 0                   | 2           |
| Cape Hatteras (CAHA)         | Barrier Island Marsh      | Photo Point + Species composition | 29            | 14              | 14                      | 57                  | 29          |
| Congaree (CONG)              | Loblolly Pine             | FMH Forest Plot                   |               | 5               | 5                       | 10                  | 5           |
|                              | Longleaf Pine             | FMH Forest Plot                   |               | 5               | 5                       | 10                  | 5           |
| Cowpens (COWP)               | Southern Red Oak          | FMH Forest Plot                   |               |                 |                         | 0                   | 2           |
| Cumberland Gap (CUGA)        | Scarlet Oak               | FMH Forest Plot                   |               | 7               | 7                       | 14                  | 16          |
| Great Smoky Mountains (GRSM) | Yellow Pine               | FMH Forest Plot                   |               |                 | 7                       | 7                   | 27          |
|                              | Scarlet Oak               | FMH Forest Plot                   |               |                 |                         | 0                   | 15          |
|                              | Alternative Monitoring    | CBI + Species Composition         |               |                 | 15                      | 15                  | 15          |
|                              | CBI                       | CBI                               |               |                 | 5                       | 5                   | 70          |
| Kings Mountain (KIMO)        | Blackjack Oak             | FMH Forest Plot                   |               | 2               | 2                       | 4                   | 8           |
|                              | Chestnut Oak              | FMH Forest Plot                   |               |                 | 1                       | 1                   | 21          |
| Moore's Creek (MOCR)         | Photo Points              | Photo Point                       |               |                 |                         | 0                   | 1           |
| Totals                       |                           |                                   | 33            | 37              | 79                      | 149                 | 253         |

Calendar year 2012 was a very busy year, with eight of our nine parks completing prescribed burns for a total of 22 burns and 4,316 acres treated (**Table 2**). As a rule, the 2012 burns were a smashing success, and burn objectives were met in nearly all cases. Even projects that were not completed due to being out of prescription (Lynn Hollow and Wear Cove Gap at GRSM) were

marked by excellent preparation and planning. Tremendous credit goes to both the Cumberland Gap and Great Smoky Mountains Wildland Fire Modules, as well all Fire and collateral-Fire folks throughout the region, for exemplary planning and execution. Credit also goes to our Fire Effects Team members, who continued to provide outstanding operational and monitoring services for prescribed burning throughout the region, participating in planning, implementation, and monitoring for every one of the prescribed burns completed in our park cluster. Discussions of each of these burns along with monitoring results can be found in each park's respective section of this report.

**Table 2. Summary of 2012 Prescribed Burns and Monitoring**

| Park                  | Burn Unit         | Plots?                | Other Monitoring*   | Acres       |
|-----------------------|-------------------|-----------------------|---------------------|-------------|
| Big South Fork        | Burke Fields      | No                    | Yes (FEMO)          | 30          |
|                       | Gobblers Knob B   | Yes (fuels transects) | Yes (FEMO, Qualit.) | 531         |
| Cape Hatteras         | Bodie Island 1.4  | Yes (photo plots)     | Yes (FEMO)          | 660         |
|                       | Bodie Island 1.5  | Yes (photo plots)     | Yes (FEMO)          | 661         |
| Congaree              | RCW               | Yes (full plots)      | Yes (FEMO, Qualit.) | 248         |
|                       | Harry Hampton VC  | Yes (full plots)      | Yes (FEMO)          | 259         |
|                       | Red Bluff         | Yes (full plots)      | Yes (FEMO, Qualit.) | 156         |
| Cowpens               | Dawson's Cabin    | No                    | Yes (FEMO)          | 200         |
|                       | Loop Project 1-4  | No                    | Yes (FEMO, Qualit.) | 108         |
| Cumberland Gap        | Lewis Hollow A    | Yes (full plots)      | Yes (FEMO)          | 106         |
|                       | Harlan A          | Yes (full plots)      | Yes (FEMO)          | 234         |
|                       | Campground        | Yes (full plots)      | Yes (FEMO)          | 50          |
| Great Smoky Mountains | Sparks Lane       | No                    | Yes (FEMO, Qualit.) | 113         |
|                       | Maple Branch      | No                    | Yes (FEMO, Qualit.) | 174         |
|                       | Old Field         | No                    | Yes (FEMO, Qualit.) | 60          |
|                       | Cemetery Marsh    | No                    | Yes (FEMO, Qualit.) | 181         |
|                       | Elijah Oliver     | No                    | Yes (FEMO, Qualit.) | 10          |
|                       | Martha's Branch   | No                    | Yes (FEMO, Qualit.) | 9           |
|                       | Lynn Hollow Piles | No                    | Yes (FEMO, Qualit.) | 10          |
| Kings Mountain        | WTP               | No                    | Yes (FEMO, Qualit.) | 125         |
|                       | North-Central     | Yes (full plots)      | Yes (FEMO, Qualit.) | 381         |
| Moore's Creek         | Savanna           | Yes (photo points)    | Yes (FEMO)          | 10          |
| <b>Totals</b>         | <b>22</b>         | <b>11</b>             | <b>22</b>           | <b>4316</b> |

\*Other Monitoring includes burn-day (FEMO) and/or qualitative post-burn evaluation

The fire effects team roster remained stable in 2012, and all team members continued to serve the Great Smoky Mountains N.P., the Southeast Region, the National Park Service, and the public interest at large with a growing set of skills and tremendous versatility (**Table 3**). Aside from serving in a variety of roles during national and local incidents, team members provided training and education to a variety of audiences, as well as invaluable assistance to several fire-related research projects. Additionally, each team member was able to complete either classroom training or a fireline-trainee assignment to support his/her Individual Development Plan.

During 2012 the program received GIS-Support funding to hire a one-year intern named Mark Vaughn. Mark has been working with a large number of parks in the Southeast Region to create spatial fire-occurrence databases according to the most recent NPS data standards. While not explicitly engaged in fire-effects monitoring, Mark is creating fire and fuel-treatment mapping products that are integral to all fire ecology and fire-effects projects. More about Mark's work can be found in the Research Update section in the following pages. Notably, Mark has also been able to earn his first red-card and play a supporting role in wildfire management at Great Smoky Mountains, as well as providing GIS expertise during the earliest stages of Hurricane Sandy stabilization.

**Table 3. Fire Ecology Staffing 2012**

| Staff                                   | Starting Date | Ending Date | # of Pay Periods | READ Qualified (Yes or No) | Training and Development                                                                                                                                                                          |
|-----------------------------------------|---------------|-------------|------------------|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Rob Klein</b><br>(Fire Ecologist)    | 1/1/12        | 12/31/12    | 26               | Yes                        | READ on Gulf Oil Spill and Hurricane Sandy Recovery; Several FIRB(t) opportunities; Partner in 4 fire-related research projects; Led fire ecology field trip for forest ecology class from Purdue |
| <b>Wylie Paxton</b><br>(Lead Monitor)   | 1/1/12        | 12/31/12    | 26               | Yes                        | READ on Gulf Oil Spill and Hurricane Sandy Recovery; SER Helicopter Detail; GIS intermediate level training; Presented overview of CBI monitoring at Fire Learning Network Meeting                |
| <b>Matt Wood</b><br>(Assistant Lead)    | 1/1/12        | 12/31/12    | 26               | No                         | 14-day IA engine assign in OK; Assisted with GRSM tornado effects research; Presented overview of new species composition monitoring protocol at Fire Learning Network Meeting                    |
| <b>Bob Dellinger</b><br>(Crewmember)    | 3/12/12       | 11/15/12    | 18               | Yes                        | Completed FIRB taskbook; READ on Gulf Oil Spill, Fire Assign FL; Major involvement with bird research project in GRSM burned areas                                                                |
| <b>Huma Alvarado</b><br>(Crewmember)    | 3/12/12       | 10/19/12    | 16               | Yes                        | WFR Refresher; Intro GIS training; Assisted with herps research in GRSM burned areas                                                                                                              |
| <b>Mark Vaughn</b><br>(Fire GIS Intern) | 6/1/2012      | 12/31/12    |                  | No                         | S-130/190; GISS(t) during first weeks of Hurricane Sandy response; Experience on 3 wildfires; S-131; S-212                                                                                        |

## ***B. Research Update***

2012 was not only a great year for prescribed burning, but also for fire-related research and data development. We were very fortunate to be involved in several interesting projects at Great Smoky Mountains that should provide valuable information for fire and resource managers at many other eastern parks. Work continued on Dr. Cecil Frost's research into the fire history at Big South Fork, and a similar project for Kings Mountain and Cowpens Battlefields in South Carolina may be funded in 2013. The proposal for GIS Data Development that we reported on in last year's report was successfully funded, and finally, a research proposal that we submitted late in 2012 to study remote sensing of burn severity was recently chosen to receive funding.

Updates and information about ongoing research can be found below. The projects are grouped under the funding source, which is underlined. These projects all have great potential to enhance our understanding and management of fire in the Southeast Region, and we are eager to work with folks at all our parks to identify additional research questions. As always, please contact Rob Klein or Caroline Noble (SER Regional Fire Ecologist) with any and all research needs, ideas, or interested partners.

### **Joint Fire Science Program (JFSP)**

#### **Southern Appalachian Dendrochronology/Fire History Study**

Progress continues on development of final products from this research. Will Flatley of Texas A&M University and Lisa LaForest of the University of Tennessee both successfully defended their Doctoral Dissertations and are currently drafting manuscripts for publication of the data. Chris Underwood of UT is also progressing toward completion of a doctoral dissertation associated with this project. Additionally, several Master's-level and undergraduate projects, that were either funded by the same grant or follow up on the grant research, have been completed. We are in the process of compiling that information and hope to synthesize the findings in the coming year.

#### **Simulating Historic Landscape Patterns of Fire in the Great Smoky Mountains National Park: Implications for Fire History and Management**

This is an interesting study currently underway by a student of Dr. Charles Lafon at Texas A&M University. This work is focused on using landscape fire modeling (FARSITE) to compare fire sizes on the current GRSM landscape with those that might have burned during the historical period prior to park establishment and fire suppression policies. The work relies on fire history reconstructions from the Dendrochronology study mentioned above.

#### **Fire and Ecology of Indiana Bats in the Southern Appalachians**

This study is entering its final year of funding. The Lynn Hollow prescribed burn at Great Smoky Mountains, which is one of the principal study sites for this research, was not burned in 2012 due to poor air dispersion on the planned burn date. There are plans to try to complete the burn during 2013 if funding becomes available. The study has produced many interesting preliminary findings, which have in turn provided a tremendous benefit to fuels management planning at GRSM. These early results were described in last year's annual report.

The principal investigators are putting on a workshop to present their findings on April 16-17, 2013 in Fontana Village, NC. Rob Klein will be attending and presenting.

### **NPS Fuels-Reserve Research Fund**

#### **Pre-settlement Vegetation and Fire Regimes at Big South Fork NRA**

This project was described in last year's annual report. Dr. Cecil Frost, the principal investigator for the study, tells us that he made significant progress during 2012. It is not clear at this time when the final products are to be expected.

#### **Pre-European Vegetation and Fire Regimes at King's Mt. NMP and Cowpens NB**

Very similar to the BISO project above, this project would apply Dr. Frost's landscape fire ecology analysis to two of our parks. Notably, Kings Mountain NMP manages a large percentage of its landscape with prescribed fire and this information would provide great support for the revision of the Fire Management Plan and fuels management schedule. Cowpens NB contains a Federally-threatened plant species for which historical insights about disturbance might offer great benefits for managers. The proposal for this project was submitted during the 2012 call for proposals, and it was ranked *third* among all proposals nationally. Full funding for the project is pending budget negotiations.

#### **Evaluation of Burn Severity Maps (dNBR) for Prediction of Fuel Treatment Effectiveness and Plant Community Response in Great Smoky Mountains NP**

The proposal for this project was also submitted during the 2012 call for proposals, and it was ranked *first* among all proposals nationally. The full proposal can be found in **Appendix A** of this annual report. The proposed research is an extension of work that was begun by our fire ecology/fire effects program, and our partners are Dr. Laura Dewald and MS candidate Scott Abila at Western Carolina University in Cullowhee, NC. The original impetus for the work was the desire to provide a more complete picture to managers of what landscape fire-effects look like over space and time. We believe that this methodology has tremendous potential to provide a supplement or alternative to our traditional long-term monitoring efforts, which should help to optimize our adaptive management processes. In addition to the research in GRSM, we have plans to develop this monitoring tool at several other parks including Big South Fork, Kings Mt., and Cumberland Gap.

### **Natural Resources Preservation Project (NRPP) and Tallasse Fund**

#### **Avian Communities of Fire-Impacted Areas within GRSM**

Field work on this study began during early 2012, and a tremendous amount was accomplished during this first year. M.S. candidate Eli Rose of North Carolina State University (advisor Dr. Ted Simons) worked closely with Bob Dellinger of our fire-effects team and several other folks from GRSM resource management to select good field sites and develop field sampling

protocols. Early results suggest that initial fire severity and time-since-burned may be useful for predicting the bird species that can be found in burned sites in the west end of the park. We are looking forward to the second field season of this study in the coming year.

## **USGS**

### **Responses of Herpetological Communities to Fire Management Practices in Pine-Oak Forests of GRSM**

This was another fire-related study shepherded by Kris Johnson, the Supervisory Forester at GRSM that got off the ground in 2012. The goals of this two-year study are to monitor selected amphibians and reptiles in burned vs. unburned areas and to characterize burned areas by microclimate profiles that can be used in species-occurrence models. Preliminary results suggest that salamanders are differentially affected by fire occurrence and severity. Fire ecology staff also played an important role in the planning and field sampling for this interesting study, providing burn maps, remotely-sensed severity data, and field support.

## **NPS GIS Data Development Project Fund**

### **Mapping of Fires and Fuels Projects for Southeast Region Parks**

As mentioned above, we were able to hire Mark Vaughn as a GIS intern for a one-year term to create spatial fire-occurrence databases for most of our supported parks. In plain language, the final products from this work will be fire history maps that show past wildfires, prescribed fires, and mechanical treatments. These will be databases that can be viewed in a GIS environment, or, in the near future, in a user-friendly web application such as NP-Map. The value of such a database is great, from simply documenting resource management actions to providing a record for national-level administrators, local researchers and other cooperators. Three important features of these databases are:

- They provide consistent records for a number of different parks
- They are consistent with the most recent NPS data standards, and
- They provide a relatively easy means of adding new records in years to come.

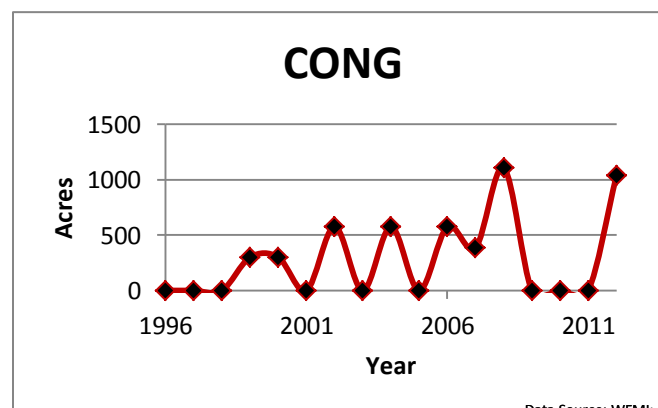
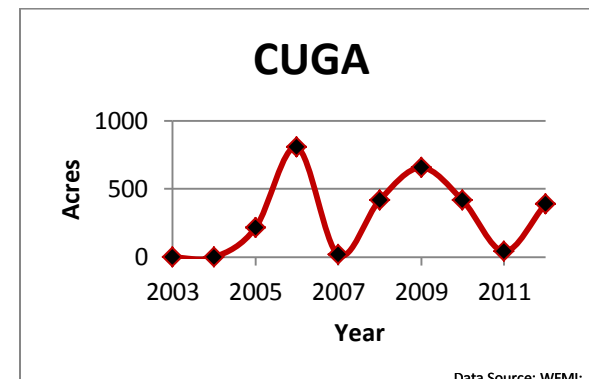
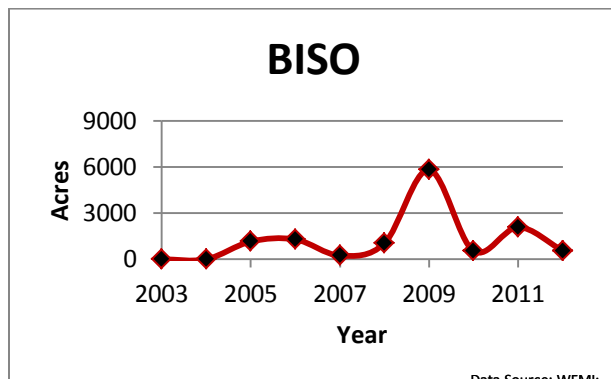
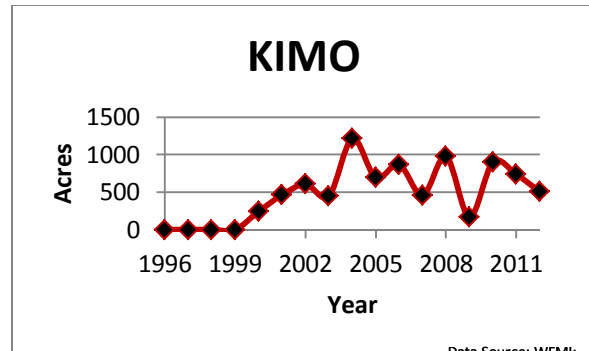
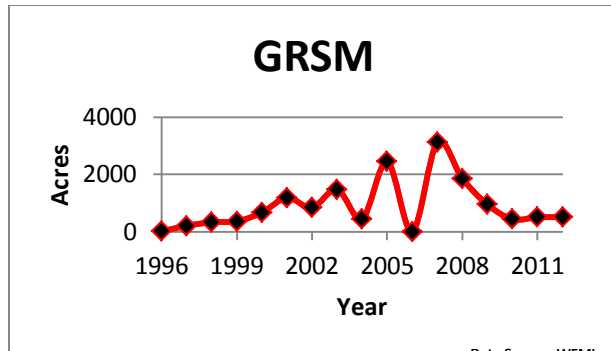
So far, Mark has largely completed databases for the following parks:

|                     |                 |               |
|---------------------|-----------------|---------------|
| Great Smokies       | Mammoth Cave    | Cape Hatteras |
| Big South Fork      | Gulf Islands    | Cowpens       |
| Little River Canyon | Cumberland Gap  | Congaree      |
| Russell Cave        | King's Mountain |               |

Charts that summarize some of the data contained in these new databases are featured below.

Some of these parks have little or no spatial data (i.e. maps) for past wildfires or prescribed fires, so there remain gaps in these databases. As time goes on, these gaps can still be filled as old records are discovered. ***Most importantly, this project will be a success if we are able to add good records for all wildfires, prescribed burns, and mechanical treatments going forward.*** Time permitting, Mark will create similar databases for additional parks that have significant wildfire occurrence or fuels management programs. If you have any questions about this project or future plans for fire mapping, please contact the Fire Ecologist, Rob Klein.

### Annual Prescribed Fire Acreage Totals for Selected Parks



## ***C. Results***

The following sections are divided alphabetically by park and each contains:

- an update on fire effects monitoring and fire ecology activities
- review of 2012 prescribed burns
- analysis of long-term fire-effects monitoring data
- summary of major fire effects findings to date.

*A new analysis of long-term monitoring results has only been completed when the past year's monitoring has added data that is directly relevant to the long-term analyses. A new column in the monitoring results table indicates when the latest analysis was completed. In some cases, the past year's data may not fit with the long-term analyses, but are summarized in the review of last's years prescribed burns. As always, park resource and fire managers are encouraged to address any additional fire-effects questions or needs to the Fire Ecologist or Lead Monitor.*

For parks that don't have an updated analysis of long-term data, more attention has been given to the review of the past year's projects or additional data analyses. The information gained from the project reviews is often more valuable for making management decisions in the near term, and these reviews are the most valuable part of this annual report for stimulating adaptive management discussions. The fire effects team has spent a lot of time and effort over the past two years developing and implementing a variety of monitoring methods that have greatly enhanced our ability to provide more immediate and scientifically accurate feedback to managers about their prescribed burn programs and the most recent burns. Any comments or feedback are always welcome.

# Big South Fork National River and Recreation Area (BISO): 2012 Fire Effects Monitoring Annual Report

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## Activity Summary

The monitoring crew made seven trips to BISO during 2012. In addition to contributing to the successful completion of the Burke Fields and Gobblers Knob B-1 prescribed burns, several trips focused on pre-burn and post-burn monitoring of the Gobblers Knob burn. A detailed account of that prescribed burn and the associated monitoring can be found in this report.

The crew completed all scheduled long-term monitoring plot visits in 2012, though data collection in five of those plots was limited to varying degrees by the presence of hazardous snags. The current strategy for dealing with situations like these is to complete as much work as can be safely done, complete a qualitative description of plot condition, and repeat until the plot is safe to work in. Long-term monitoring included work in the Divide Road, Bald Knob, and Newtie King burn areas. An additional trip was made in August to conduct field-testing of a new protocol that is focused on using remote sensing to model landscape fire effects on vegetation and fuels. This work was done in the Divide Road and Darrow Ridge burn areas. Some of the findings from this field testing are discussed in this report, and a more detailed discussion of the protocol and modeling effort will be forthcoming this year.

The fire ecologist made five visits to BISO during 2012, which included trips to present a fire ecology talk to park staff, conduct pre-burn field work, monitor during the Burke Fields and Gobblers Knob B1 burns, conduct immediate post burn monitoring, and lead field testing for the new sampling protocol. The BISO fire ecology presentation provided a good overview of the evolution of the fire program and a good opportunity to solidify recent program improvements. The complete powerpoint presentation can be found on the SER Fire Sharepoint site.

One final point about the activities of the fire ecology/fire effects team concerns participation in the prescribed burns. Aside from greatly improving our ability to understand and communicate about fire effects, it is clear that participation of our team members during the final burn planning and implementation increases the chance for success, especially in large forested landscape burns. We will continue to prioritize working on prescribed burns at BISO, but the park is also encouraged to request our participation.

## Program Goals and Objectives

One of the successes of our fire-effects monitoring program has been its contribution to the development of short and long-term objectives for the prescribed fire program. Monitoring data have been continually used to evaluate and improve objectives, and this is indicative of major advances in understanding Appalachian fire ecology over the past 15 years.

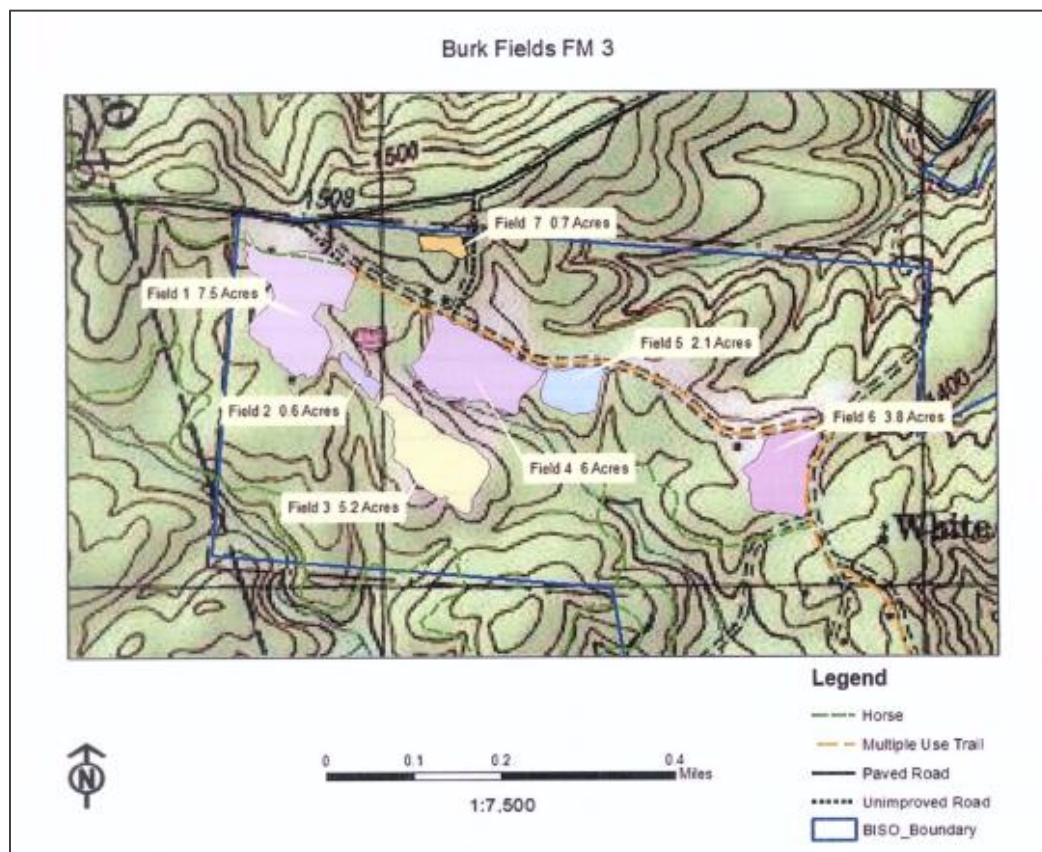
In past years' reports, we've used this space to communicate existing goals and objectives and to improve the objectives as new data have become available. There are no significant changes in goals and objectives for BISO, so in the interest of not being repetitive, the reader is referred to last year's report, which can be found at the SER Sharepoint site.

## Review of 2012 Projects

### **Burke Fields (30 acres):**

The Burke Fields are located in Scott County, TN, just south of TN Highway 297 approximately 2.5 road miles west of Leatherwood Ford. The landscape is level to gently sloping, and vegetation varies from planted native warm-season grass (NWSG) to old fields in various stages of woody succession. Field 1 (**Figure 1**) is currently being managed for production of straw for use in road stabilization, and had very low fuel loading just prior to burning. These fields and the surrounding woodlots are believed to have been last burned in April 2008. The 2012 burning was limited to seven small fields. Note that Field 7 on the map was not actually burned, though a small field (<1.0 acre) directly south of it was burned.

**Figure 1.** Map of Burke Fields Prescribed Burn Area





The objectives for this subunit were basically to reduce fuels, primarily leaf litter, and to reduce density of shrubs, tree seedlings and poles while maintaining most of the overstory, specifically dry mesic oak and yellow pines, across the target area over the long term. The first Gobbler's Knob burn was very effective at accomplishing these objectives, especially with regard to retention of overstory oak and top-killing of fire intolerant tree seedling and poles including significant amounts of red maple (*Acer rubrum*).

The B-1 subunit had a false start on 3/7/12 when high winds almost immediately contributed to a small slop-over which resulted in the burn being postponed. B-1 was successfully burned on 3/11/12, three days following a significant rain event (2"). Relative humidities were low on burn day, bottoming out at 21% around 1300, temporarily delaying firing operations. Despite dry conditions, severity was moderated by firing technique and residual moisture from the recent rainfall. Generally, day-of fire behavior was observed to be low to low/moderate intensity, mostly backing and flanking from the ridgetops and upper slopes down to the drainages.

Fuels transects were installed just prior to the B-1 subunit burn in areas of white oak (*Quercus alba*) / scarlet oak (*Quercus coccinea*) forest with occasional areas of understory mountain laurel and fuel loading from beetle-killed yellow pine, which comprises the bulk of the ridgetop target vegetation (**Figure 1**). Post burn measurements on these transects (**Table 1**) indicated high consumption of leaf litter, moderate reduction of fine woody fuels (1-hr, 10-hr, and 100-hr), and little change in duff and 1000+hr fuels. Additionally, post burn reconnaissance and post burn severity satellite imagery (despite missing data from scan line errors) both appear to confirm the initial assessment that burn severity was low with minimal effect on the overstory, but with significant top-killing of undesirable fire-intolerant tree seedling and pole species (especially red maple) in the understory and midstory.

**Table 1. Gobbler's Knob B-1 Fuels Transects Immediate Fire Effects** (n=4 transects)

| Substrate Severity | Vegetation Severity      | Fine Woody Fuels (1s, 10s, 100s) | 1000hr Fuels            | Litter | Duff | Total Fuels |
|--------------------|--------------------------|----------------------------------|-------------------------|--------|------|-------------|
| 3<br>Light burn    | 4<br>Scorch (very light) | -53%                             | +8%<br>(no real change) | -98%   | -18% | -40%        |

Overall, this 2<sup>nd</sup> entry into the B-1 area of Gobbler's Knob appears to complement the fire effects of the initial entry by meeting the burn objectives of overstory retention, leaf litter fuel reduction, and thinning of shrubs and fire intolerant tree seedlings and poles (especially red maple).

## **Alternative Monitoring (Landscape Fire Effects Mapping):**

### **Background**

The Southern Appalachian/Piedmont fire ecology team has been in existence for over fifteen years, and we have been working in the forests and glades of Big South Fork for eight years. During this time, we have relied heavily upon the monitoring protocols contained in the NPS Fire Monitoring Handbook (FMH), which are the national standard. Data gathered using FMH methods has allowed us to contribute to significant advances in resource and fuels objectives-setting, prescribed burning practices, and regional understanding of fire effects.

However, FMH methods are very intensive, which results in more time spent in each plot and a lower number of total plots than might be achieved through other methods. Growing concerns about safety (exposure time to snags) and the limitations of our sample size to accurately represent the variability of fire effects in a timely fashion prompted us to explore other ways to meet our monitoring goals. Fortunately, we have access to an additional data source that lends itself well to our evolving needs.

We have used remotely-sensed burn severity mapping (known as dNBR) to illustrate fire effects across burned landscapes for several years (see last year's annual report), but without ground-truthing data these maps remain a bit of an abstraction. During the 2012 field season, we worked on the development and testing of a ground-truthing protocol with the goals of providing fuels and vegetation data that can be used in conjunction with dNBR data to develop models of landscape fire effects at a variety of scales. Further background on these alternative monitoring efforts, along with a full description of the protocols and intended analyses will become available in the coming year.

### **Results and Discussion of Field Testing**

Most of the protocol development and field testing for the alternative monitoring were conducted at GRSM, but we were able to spend one and half days testing the methods in the field at BISO during early August. During that brief time, we were able to complete data collection in five plots in two different burn units, Divide Road and Darrow Ridge. Field testing and additional reconnaissance suggest that the dNBR data for Darrow Ridge are well correlated with on-the-ground conditions in that burn site, which is very similar to the majority of results that we've seen while working with other dNBR data over the past six years.

Conversely, the field tests revealed problems with existing dNBR data for Divide Road. Specifically, dNBR values seem to greatly underrepresent the overall severity for certain portions of the Divide Road burn site. After reviewing the source imagery for that dNBR analysis, we are fairly confident that the inaccuracies can be traced back to timing of the imagery used for processing. It is possible that this can be improved by selecting more appropriate imagery, and we plan to work on that in the coming year.

To help provide a simplified illustration of our field test results and show some of the products that can be created with the data, we focus here on the two plots from Darrow Ridge (More examples of field testing results can be found in the GRSM report). **Figure 1** below shows a classified dNBR image of the western-most portion of the Darrow Ridge prescribed burn site

with two of our test plots. Note the pattern of severity on the landscape. **Figure 2** provides the same view, with the burn severity classes overlying the BISO vegetation layer. Here you can see quite nicely that the two plots represent the same Oak-Heath Forest vegetation type, but that they have experienced very different burn severity according to the dNBR model.

Field data collection is designed to help describe differences in vegetation and fuels resulting from these various combinations of vegetation and severity. **Figures 3** and **4** below are plot photos that illustrate the important structural differences between our two test plots. Finally, **Table 1** demonstrates the wealth of structural and compositional data that can be derived from our methods. As in the photos, distinct differences in structure can be observed between plots, and these differences clearly correspond to dNBR values (higher dNBR = more severe).

High severity in Darrow002 has resulted in extremely low canopy cover which is coupled with extremely high cover in the sapling class. By contrast, relatively high canopy cover in Darrow001, following a low-moderate severity burn, is associated with lower sapling cover, and a relative lack of oak and shortleaf pine saplings as compared with Darrow002. These structural and compositional differences will result in dramatically different vegetation and fuel dynamics. Such data provide valuable information that is needed to accurately address program effectiveness, improve future fire operations, and understand the fire ecology.

It should be emphasized that these are merely plot-level summaries from single test plots; the goal will be to sample enough plots that inferences can be made for various combinations of vegetation and severity. It should also be noted that our field methods include sampling of fuel load, though time did not allow for fuels data collection at Darrow Ridge.

### **Future of Landscape Fire Effects Mapping**

Taking away time for travel, breaks, and orientation to the new methods, these plots averaged about an hour to complete, suggesting that in an average week during the field season (3 – 10hr days) we might expect to complete 10-15 plots. By comparison, the same average week in summer may yield 3-5 FMH plots. Furthermore, when coupled with the dNBR imagery, the power of these plots to describe landscape scale fire effects is potentially far greater.

Now that a protocol has been developed and some field testing has occurred, the next step will be to prepare a formal proposal to the Southeast Region and the National Fire Office (Boise). Pending approval of the protocols, the goal for incorporating Landscape Fire Effects Mapping into the long-term monitoring program at BISO will be to spend roughly equal time on field data collection to support Mapping and collection of high-priority FMH plot data.

We have presented a very brief illustration of some of the products that we expect to develop using the new methods; however, the protocol is designed to produce data that is compatible with a range of additional analyses. These kind of data are especially well suited for the development of chronosequences that can help us gain a much better understanding of program effectiveness, fuel treatment lifespan/fuel recovery, and longer term vegetation dynamics for a range of scenarios. As always, we look forward to feedback and active dialogue from all interested parties about this new monitoring tool.

**Figure 1.** Classified burn severity (dnBR) map of the western part of Darrow Ridge.

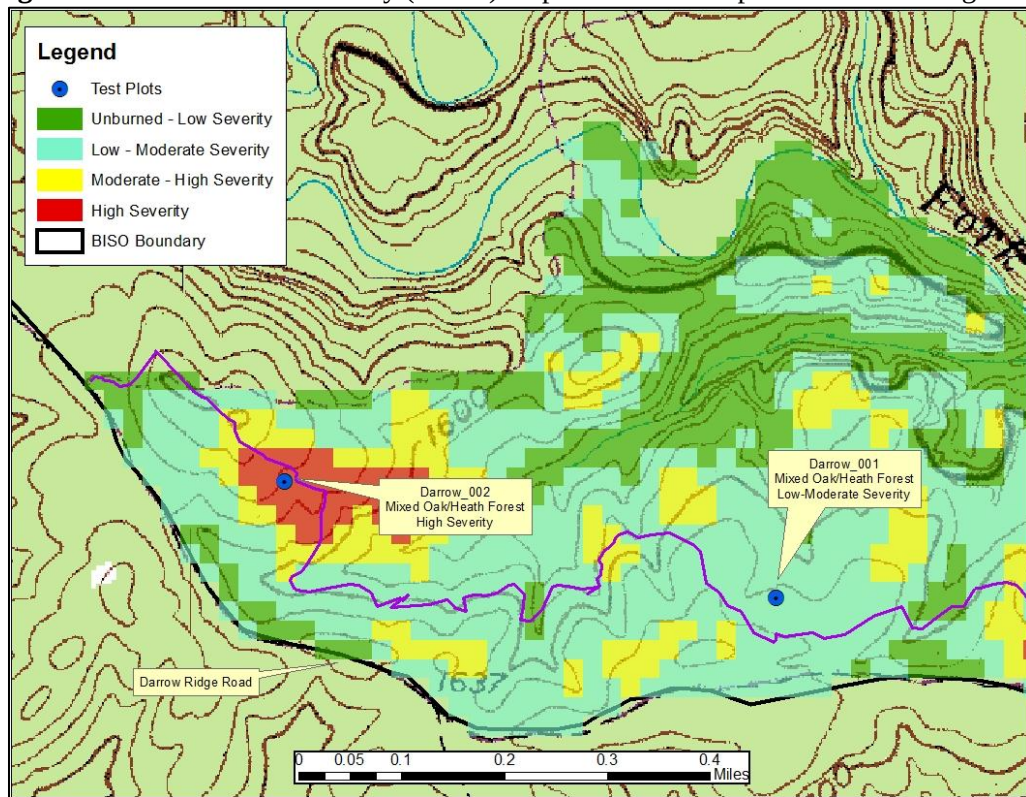


**Figure 2.** Burn severity classes overlaying vegetation at Darrow Ridge.

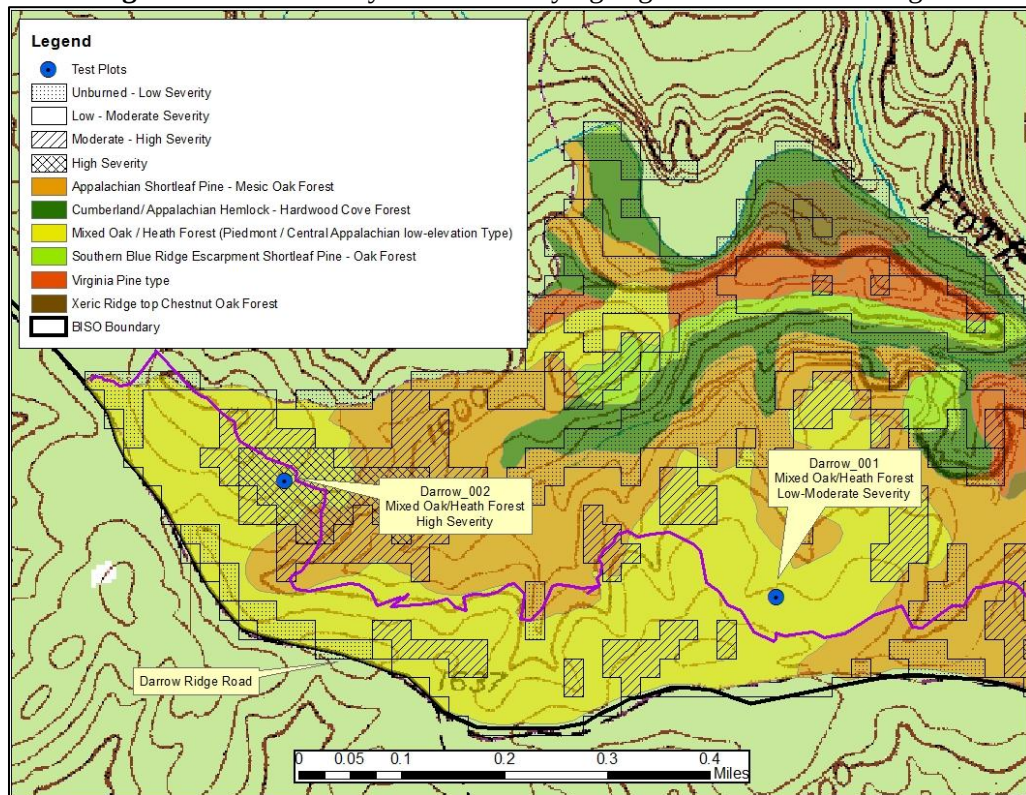




**Figure 3.** Darrow001 plot center.



**Figure 4.** Darrow002 plot center.

**Table 1.** Test plot data summaries.

|                                             | Darrow001                                        | Darrow002                                                                 |
|---------------------------------------------|--------------------------------------------------|---------------------------------------------------------------------------|
| <b>dNBR Value</b>                           | 141                                              | 715                                                                       |
| <b>CBI* Score (0 – 3, 3 highest)</b>        | 1.0                                              | 2.5                                                                       |
| <b>Total Canopy Cover</b>                   | 54%                                              | 5%                                                                        |
| <b>Top Canopy Spp. by Cover</b>             | QUEVEL, QUECOC, QUEALB                           | LIRTUL                                                                    |
| <b>Total Sapling Tree/Tall Shrub Cover</b>  | 21%                                              | 135%                                                                      |
| <b>Top Sapling/Tall Shrub Spp. by Cover</b> | ACERUB, OXYARB, NYSSYL, SASALB (2.5% cover each) | ACERUB, OXYARB, QUEALB, QUECOC, SASALB, RHUCOP, RUBUSsp. (15% cover each) |
| <b>Pine and/or Oak Saplings Present?</b>    | Trace oak                                        | Multiple oak spp. and shortleaf pine                                      |
| <b>Total Herbaceous Cover</b>               | 47%                                              | 60%                                                                       |
| <b># of Herbaceous Spp</b>                  | 24                                               | 19                                                                        |

\* CBI is Composite Burn Index, a plot-based measure of burn severity

## Long Term Monitoring Results

Last year's annual report featured an update to the standard analysis of long-term monitoring results (FMH protocols), and no additional data were collected during 2012 that would change those results. Consequently, **Table 2** has not been updated for this report, though we include it below as a reference for reviewing the progress toward achieving program objectives. As noted last year, the results suggest that BISO is making good progress toward achieving the long-term objectives of the prescribed fire program, particularly in the dry oak forest type. The minimum-plot analyses for the dry oak forest type indicate that more plots are needed to achieve the desired confidence level for oak seedling density and herbaceous cover. Given the FMH sample design, however, installation of additional plots is unlikely without the addition of new burn units. Further discussion regarding the results of **Table 2** can be found in last year's report.

**Table 2.** Objectives and long-term monitoring results for BISO

| Vegetation Type                                                           | Management Objective<br>Restoration Phase-<br>(After 4 burns) | Monitoring Results<br>(80% confidence intervals)                                                                 | Objective Achieved?                               | Year Last Analysis Completed |
|---------------------------------------------------------------------------|---------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|------------------------------|
| Dry Oak Forest<br>(FQUAL1)<br><br><b>14 plots</b>                         | >50% Reduction in total fuel loading                          | Total fuel reduction<br>After one burn = 52% ( $\pm 2\%$ )<br>( $n=10$ plots)                                    | <b>Yes, but will require more time to assess.</b> | <b>2012</b>                  |
|                                                                           | >70% Reduction in pole-sized tree density ( $\leq 15$ cm dbh) | Pole reduction<br>After one burn = 58% ( $\pm 7\%$ )<br>( $n=10$ plots)                                          | <b>Not yet, but on course.</b>                    | <b>2012</b>                  |
|                                                                           | 20-40% Reduction in overstory tree density ( $>15$ cm dbh)    | Overstory reduction<br>After one burn = 4% ( $\pm 2\%$ )<br>( $n=11$ plots)                                      | <b>Not yet, but this is a long-term objective</b> | <b>2012</b>                  |
|                                                                           | >200 tall ( $>1$ m) Oak seedlings /ac                         | Preburn mean: 96/acre ( $\pm 43$ )<br>Post-burn mean: 103/acre ( $\pm 35$ )<br>( $n=11$ plots)                   | <b>Not after a single burn.</b>                   | <b>2012</b>                  |
|                                                                           | >30% Cover by native herbs                                    | After 1 burn: 14% ( $\pm 5$ )<br>( $n=11$ plots)                                                                 | <b>Not after a single burn.</b>                   | <b>2012</b>                  |
| Little Bluestem Sandstone Glade/Savanna<br>(FSCSC1)<br><br><b>3 plots</b> | >70% Reduction in pole-sized tree density                     | Pole reduction:<br>After one burn = 16% ( $\pm 11\%$ )<br>After two burns = 30% ( $\pm 14\%$ )<br>( $n=3$ plots) | <b>Not yet, but on course.</b>                    | <b>2011</b>                  |
|                                                                           | >100% Cover by native herbs                                   | Preburn cover: 98% ( $\pm 26$ )<br>After 1 burn: 123% ( $\pm 28$ )<br>After 2 burns: 133% (30)<br>( $n=3$ plots) | <b>Yes, but not with 80% confidence</b>           | <b>2011</b>                  |

Note: Underscored sample size indicates that minimum plot numbers exist for  $\alpha = 0.20$

### Additional Analyses

There is a wealth of additional data from our long-term FMH monitoring that can be used to explore various aspects of fire-effects at BISO. Recognizing that the table of long-term monitoring data (**Table 2** above) averages results from plots that have very different burn treatments and has limited explanatory power, this year we have conducted additional analyses

that may provide more insight into the status and trends for key ecological variables. Additionally, insights gained from analysis of the BISO data may be applicable to a number of the other parks in our region, most notably those that contain Appalachian oak forest.

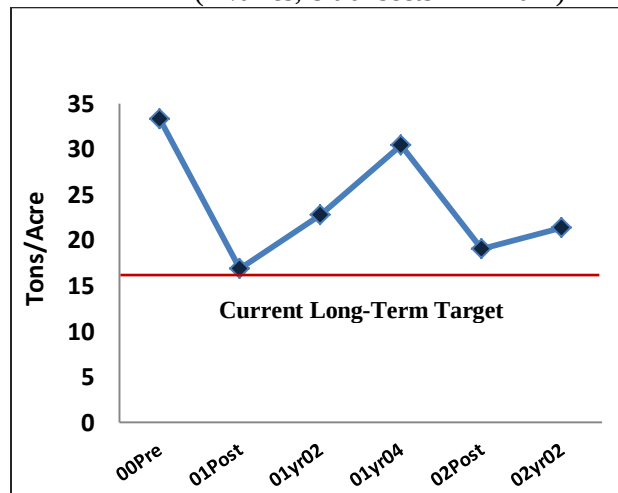
Two of the most critical objectives for our prescribed fire programs are reduction of hazardous fuels and balancing reductions of shade-tolerant woody stems with protection of overstory oak and shortleaf pine. The following analyses utilize seven years-worth of monitoring data from BISO to explore dynamics in fuels and overstory trees.

### Fuels

Management of fuels is a primary objective of the prescribed-fire program at BISO, and Fuels Management has been the principal source of national funding for the program through the years. Whether in the Wildland-Urban-Interface or along the NRRA boundary with public and private landholdings, the BISO landscape lies in a geographic zone that has experienced tremendous accumulations of heavy wildland fuels over the past decade. These accumulations have resulted from an historical southern-pine-beetle outbreak in the early-2000s, along with ice storms and wind events. The result is a forested ecosystem that is vulnerable to catastrophic damage from severe wildfires, such as the Schoolhouse and Darrow Ridge fires of 2000.

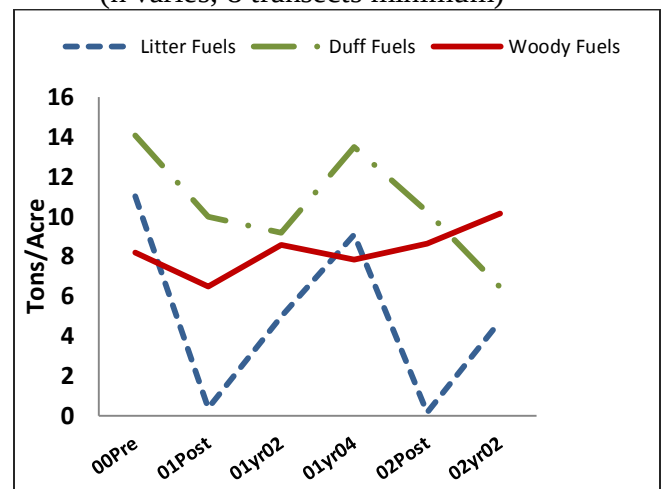
The long-term target for fuels management at BISO is a 50% reduction of total fuels after four burns (**Table 2**). Data averaged from 11 plots spread over six burn units suggest that this objective can be achieved after a single burn (**Figure 1**), however much of this initial reduction comes from leaf litter consumption, which may recover to 90% of preburn levels within four

**Figure 1.** Trend in total fuel reduction  
(n varies, 8 transects minimum)



Note: Red line represents the target of 50% reduction from pre-burn mean.

**Figure 2.** Trend in major fuel components  
(n varies, 8 transects minimum)



years (**Figure 2**). That doesn't mean that litter reduction is inconsequential; litter is the major carrier of fire in this fuel type, and when it is reduced the probabilities for fire spread and severe fires are greatly lessened. Also, as the number of woody stems in our burn units is sustainably reduced, the contribution of leaf litter to total fuel loading will also be reduced.

That all said, it is clear that to achieve a meaningful and lasting 50% decrease in total fuels, there will need to be strong reductions in heavier fuels, such as woody fuels and duff. There are some encouraging signs, such as the consistent reduction in duff fuels following our burns, however woody fuels remain a challenge, especially large concentrations of 1000-hr fuels resulting from beetle-killed pines. This challenge becomes even greater when our prescribed burning practices result in high mortality levels of overstory trees, which, even in the short term, add considerably to the total fuel load. If we can continue burning on a 3-5 year cycle and limit the number of mature trees killed by prescribed burning in the short term, we will start to see woody fuels loads decline, but this will be a long-term process.

### ***Overstory Trees***

In any forested environment, proper management of overstory trees (trees >15cm or 6in dbh) is of paramount importance. Aside from fuels management, the core ecological goals of the prescribed fire program at BISO involve the management of trees. Those goals are common for several NPS units:

- Reduce the density of fire- and drought-intolerant trees on the landscape
- Protect suitable numbers of site-adapted tree species (oaks, shortleaf pine)
- Create conditions that are favorable for the regeneration of species that are site-adapted and that provide food and cover value for native wildlife.

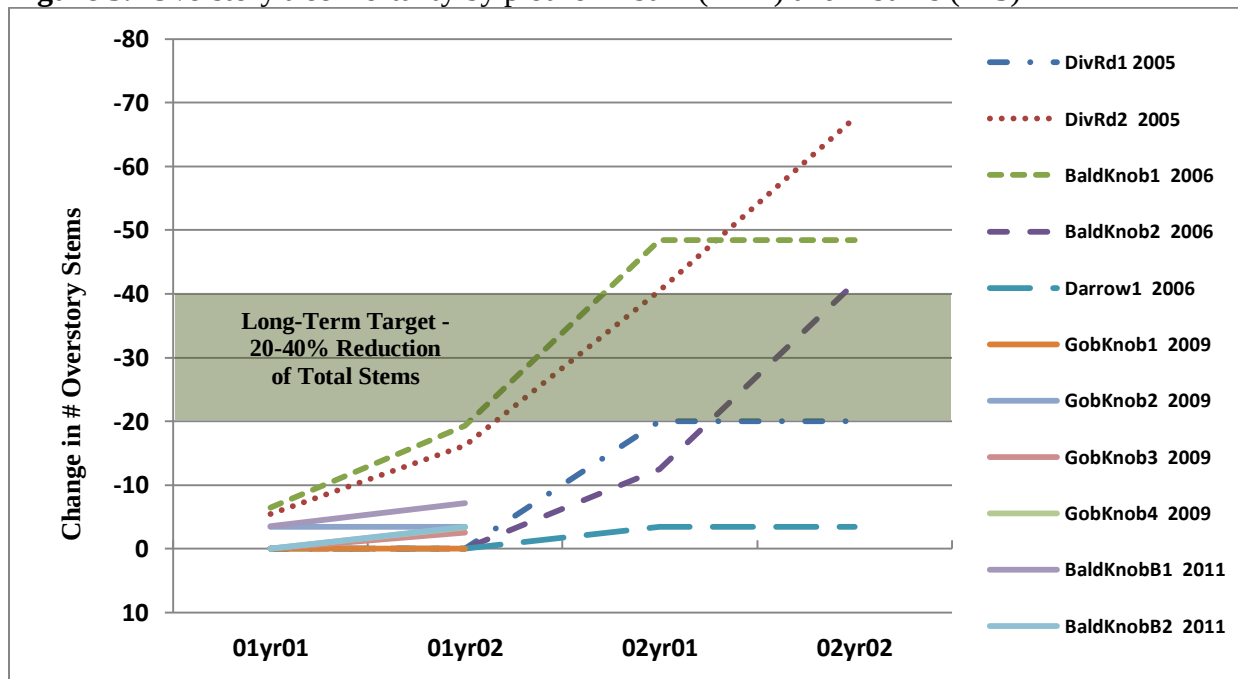
Goals to reduce the density of some trees while protecting others create a seeming contradiction that can complicate management efforts and confuse our ability to interpret the relative success of our actions. Additionally, given the long-term implications of excessive overstory mortality and the relationship between mortality and fuel loading (see ***Fuels*** analysis above), it is important to explore the monitoring data in an attempt to gain a better understanding of fire effects that can help guide management efforts and improve the accuracy of our interpretive ability. To this end we used the data to answer the questions:

1. Are we meeting our objective for reduction of tree stem density?
2. Are we meeting our objective for protecting oaks and shortleaf pine?
3. What are factors that can help explain our success or failure?
4. What adjustment(s) can we make to our prescribed burning practices to improve outcomes?

### **Are we Meeting our Objectives? (Questions 1 and 2)**

The only thing we can say within our desired 80% confidence level is that after a single burn we have not yet reached our objective (**Table 2**). This is completely acceptable and reflects the long-term, stepwise approach that we have for achieving this objective. However, we can gain tremendous additional insights into this question by exploring how the data are distributed and by contemplating the results that lie outside the 80% confidence level. **Figure 3** shows the most current monitoring data from BISO, and provides a graphic illustration of the differences between plots. Not only do twice-burned plots average nine times greater mortality (-36%, n=5) than once-burned plots, but there is a tremendous amount of variability between plots (ranging -3% to -68%) that is hidden by the average value. The fact that three of the five twice-burned plots have already exceeded the long-term target for overstory mortality is a cause for concern.

**Figure 3.** Overstory tree mortality by plot for 1 burn (n=11) and 2 burns (n=5)



**Note:** All percent changes are compared to Preburn numbers.

Even without statistical certainty, we can see that it will be difficult to achieve our long-term objectives if the conditions or practices that resulted in high levels of mortality are repeated during future burns. These results suggest that repeated burning may play a large role in high levels of tree mortality, however the wide range of outcomes is a clear indication that there are additional factors (e.g. fire intensity, tree size, subsequent droughts) that need to be considered.

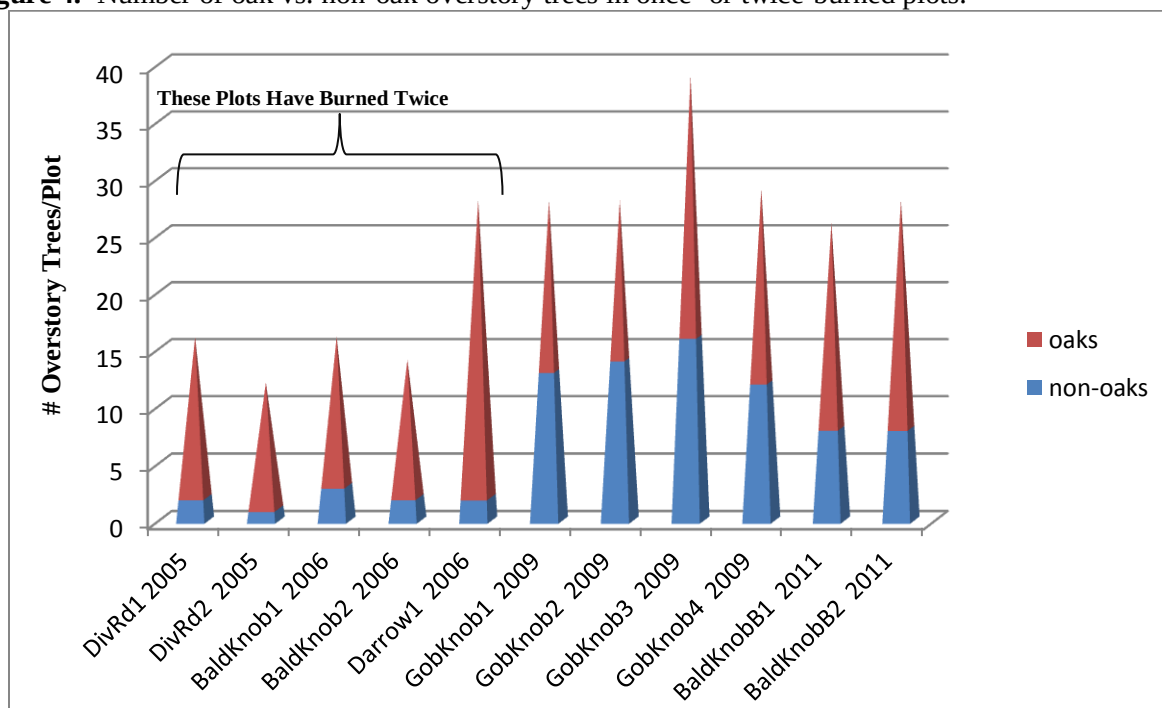
Can we tell from our data whether we are successfully protecting mature oaks (shortleaf pines are very infrequent, but none have died following prescribed burning) and whether oaks experience a different survival rate than non-oaks? **Table 3** gives the average number of trees per plot along with the percentage of those that are oak for different burn status. Though the average number of trees **and** oaks decrease with successive burns, this table shows that oaks (in our small sample) survive at a much higher rate (75% survival) than non-oaks (20% survival).

**Table 3.** Average number of trees and average number of oaks per plot by burn status.

|                        | Preburn (n=11) | After 1 Burn (n=11) | After 2 Burns (n=5) |
|------------------------|----------------|---------------------|---------------------|
| Average # trees/plot   | 29.5           | 27.9                | 17.2                |
| Average # of oaks/plot | 20.3           | 19                  | 15.2                |
| Proportion of oak      | 69%            | 68%                 | 88%                 |

**Figure 4** provides another illustration of the current status of total tree density and oak density for each burned plot. This graphic shows the effect that multiple fires have had in concentrating oaks as the predominant overstory trees.

**Figure 4.** Number of oak vs. non-oak overstory trees in once- or twice-burned plots.



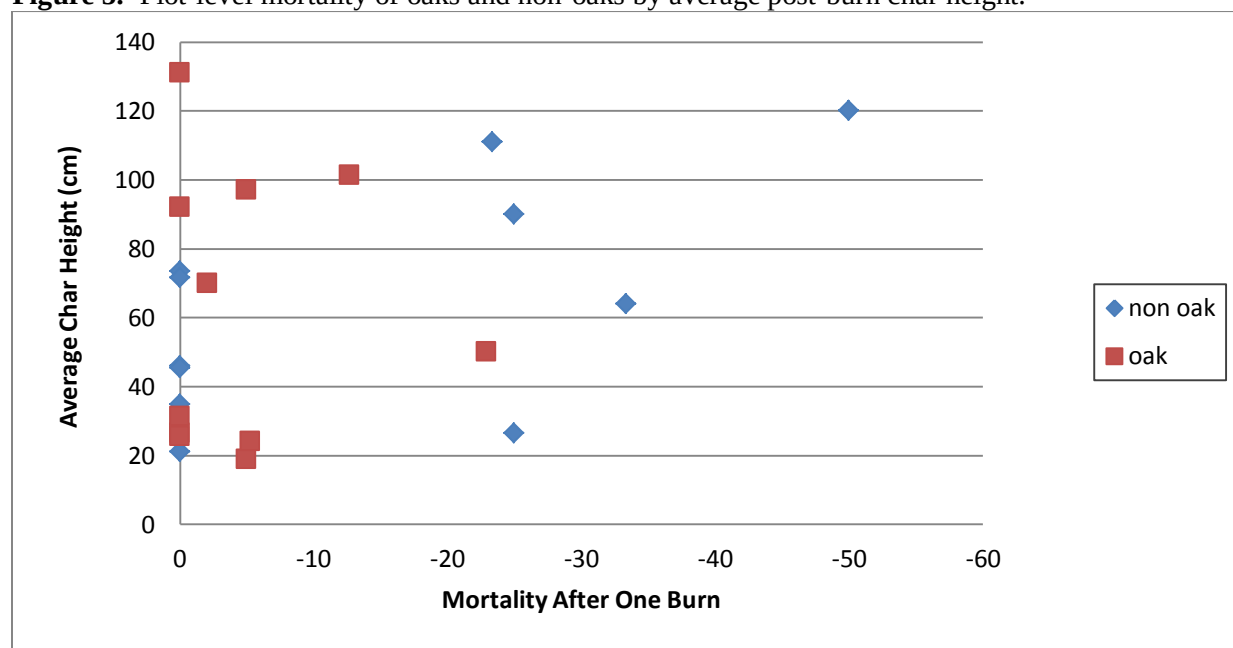
Though oaks, on average, appear to be surviving multiple burns at a reasonable level, the percent of total tree mortality after two burns (around 42%) exceeds our current long-term objectives. Coupled with the fact that, many times, even the surviving oaks have sustained serious damage from fire that makes them more likely to die following droughts or additional burns, there is reason to be concerned about excessive overstory tree mortality associated with prescribed burning at BISO. ***Though we have recognized this problem and made appropriate and successful changes to prescribed burning practices at BISO,*** we can still learn important details about how tree mortality occurs, how we can predict high mortality following wildfires or burns, and how to better control tree mortality in our prescribed burn program.

There are several factors that have been shown to be correlated to tree mortality following fire. Above, we've seen an example of one of those factors – species. Some species, like oak and pine, have thicker, more insulative bark or a better ability to compartmentalize wounds. Likewise, mortality is related to tree size; typically older trees have thicker bark and greater below-ground resources from which to draw for recovery. Short and long-term weather patterns also have a large influence on fuel consumption and the ability of certain trees to survive burning. However, aside from the selection of a burn day with appropriate short and long-term weather conditions, there is little that we have more ability to control than fire intensity, which is clearly a major factor in fire survival. ***Understanding the effects of fire intensity and then how to control fire intensity are two of the keys to successful use of fire for vegetation and fuels management in eastern forests.***

Fire intensity is technically “the energy released by the flaming front,” which can be directly measured, but is frequently described as flame length. Current monitoring methods do not measure intensity directly, but do record flame length during burns and char height immediately following burns. Char height (blackening on the tree base) has been shown in the literature to correlate reasonably well to flame length, and experience shows that post burn char height on trees (other than yellow pines) is an excellent indicator of the average flame length in a given part of the fire.

Long-term monitoring at BISO has included nearly 500 measurements of immediate post-burn char height on over 300 individual trees. Along with standard monitoring of live/dead status during each plot visit, these data allow us to explore how char height (and by substitution, flame length) relates to tree mortality. **Figures 5 and 6** below show the mortality levels for oaks and non-oaks in each plot compared to their average char height recorded for that plot. The charts are followed by several bullet points that highlight the major findings from each. Though clear differences exist between parks, we believe the broad principles of our findings are highly applicable to all of our parks that seek to manage fuels and vegetation in Appalachian oak ecosystems.

**Figure 5.** Plot-level mortality of oaks and non-oaks by average post-burn char height.



- When average char heights are >50cm (20in) after first-entry burns, there tends to be high overstory tree mortality (>20%). n = 11 plots, 6 different burns
- Non-oaks are clearly more susceptible to char heights > 50cm after a single burn
- Oaks tend to be fairly resilient following first entry burns, even when char heights exceed 1m
- High oak mortality (>20%) with only moderate average char suggests that other factors or a combination of factors may be more important in oak mortality
- Soil moisture status leading up to - and for the first growing season following the burn- is a crucial factor that is not controlled for in this analysis.
- Another factor unaccounted for here is dbh, which is known to correlate strongly with mortality. That said, these are all overstory trees (>15 cm dbh)
- All in all, oaks appear to be more resilient at BISO following first-entry burns.

**Figure 6.** Plot level mortality for oaks and non-oaks after 2 burns by highest recorded post-burn char height. (highest char may have occurred during the first or second burn)



- Multiple burns with at least one high char (>50cm) event tend to cause unacceptable levels of mortality (>40%)
- Oaks are still more resilient, but definitely lose some of their edge over non-oaks after multiple burns with at least one char event exceeding 1m (3.3ft)
- ***Char heights over 1m are indicative of fairly intense head fires***
- Current prescriptions call for using low intensity fires (backing/flanking fires <3') over the vast majority of our landscapes
- Difficulties remain within planning and implementation in achieving the goal of low intensity fire
- Such high levels of mortality have been seen in significant patches at CUGA, GRSM, KIMO and BISO, though these types of effects are best illustrated in the BISO dataset
- These high levels of mortality tremendously hinder our ability to achieve meaningful and lasting hazard fuel reduction because they dramatically increase heavy fuels
- They also greatly hinder our ability to achieve agency goals and other ecological objectives
- We are establishing tolerance thresholds that need to guide future burning

## Discussion

There are many reasons to be excited about the prescribed fire program at BISO, from the establishment of meaningful objectives to improvements in burning practices to advances in monitoring tools. This year's report seeks to showcase the monitoring data that has helped to inform those objectives and burning practices. BISO has been very successful in the past three years working with the Cumberland Gap Wildland Fire Module and GRSM Fire Effects Team to learn and apply these lessons, create appropriate plans, and skillfully implement prescribed fire for the achievement of NPS goals.

# Blue Ridge Parkway (BLRI): 2012 Fire Effects Monitoring Annual Report

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## Activity Summary

There was very little fire ecology activity at BLRI during 2012, and no fire effects monitoring work was done. The only burn project that the Parkway was involved in was the Singecat prescribed burn that was conducted by the USFS. That project essentially relied on the physical parkway as a contingency line, though very little BLRI property was actually burned. Fire ecology and effects staff conducted pre-burn scouting and were involved in initial planning for that project, but were not involved in any long term monitoring of USFS land.

A great deal of progress was made late in 2012 toward planning future prescribed burns in Doughton Park. This area contains examples of Table Mountain Pine and montane dry- oak forests, and is a centerpiece of the Southern Blue Ridge Fire Learning Network's "Northern Escarpment Landscape." Plans are under preparation for a series of multi-agency prescribed burns that feature over 6000 acres of Parkway lands. Due to the late-season planning process, no long-term monitoring has been established within upcoming burn units, though development of a monitoring strategy was begun in 2012.

## Program Goals and Objectives

In past years' reports, we've used this space to communicate existing goals and objectives and to improve the objectives as new data have become available. There are no significant changes in goals and objectives for BLRI, so in the interest of not being repetitive, the reader is referred to last year's report, which is available on the SER Sharepoint site.

## Review of 2012 Projects

No prescribed fire projects were conducted on Parkway lands in 2012.

## Long Term Monitoring Results

No data are available. Currently, two long term monitoring plots exist in the Haw Creek burn unit, but these have yet to be burned.

## Discussion

The status of funding and support for the Haw Creek prescribed burn is unclear, but it does not appear likely that this unit will be burned in 2013. As mentioned above, a tremendous amount of work has gone into development of a large-scale burn program at the Doughton Park section of BLRI, and future monitoring efforts will be focused on that area. If parts of Doughton Park are burned during the spring 2013 season, it may still be possible to establish some last-minute baseline monitoring such as tree & fuel plots or fuel transects. If large-scale burning occurs this spring, this area would become a good candidate for our Landscape Fire Effects Mapping methods which do not rely on pre-burn plot data. For a description of these methods, see the report sections for Big South Fork or Great Smoky Mountains. If it appears that large scale burning will be delayed until 2014, we will attempt to establish our standard long-term fire effects monitoring plots.

# Cape Hatteras National Seashore (CAHA): 2012 Fire Effects Monitoring Annual Report

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## Activity Summary

2012 marked the beginning of a modern prescribed fire program at Cape Hatteras, and also marked the first year that our crew has conducted fire effects monitoring at the Seashore. Fire Ecology/Fire Effects staff members made two trips to Cape Hatteras during 2012. Wylie Paxton traveled with the Cumberland Gap Wildland Fire Module in late January/early February to plan and implement the Bodie Island 1.4 and 1.5 prescribed burns. During that trip, Wylie worked with CAHA staff to develop a photo-monitoring protocol, and established permanent photo-points within both of the treated units. This work is further described in the Monitoring Results section of this report.

The Fire Ecologist and entire Fire Effects Monitoring crew were able to join SER Fire Ecologist Caroline Noble and the Northeast Region Fire Effects Lead Steve Paull at CAHA in October to more fully develop a monitoring strategy and establish plots. This trip was a major success, and a tremendous amount was accomplished during that single week. Some of the highlights:

- Toured numerous proposed fuel treatment areas by means of driving/walking tour and an overflight that highlighted WUI concerns, different veg types, and natural areas
- Met with Resource Managers and Visitor Protection to discuss the objectives of the burn program, proposed burn sites, resource concerns, compliance and planning, and the role of monitoring
- Reviewed the results of photo-point monitoring of 2012 burns
- Developed a slightly more robust form of monitoring that will supplement the photographic data with cover data for dominant vegetation
- With the help of CAHA staff, established 19 monitoring plots in two burn units – the total number of plots established in 2012 was 29 (plus 4 WUI photopoints)

## Program Goals and Objectives

The following goals and objectives were taken from the 2012-2017 Bodie Island Prescribed Burn Plan:

### **Resource Goals**

1. Reduce encroaching brush species from marsh habitats.
2. Reduce dead vegetation content of marsh grasses to improve marsh habitat for waterfowl and wading birds.
3. Maintain or improve herbaceous species diversity and cover in marsh and forested plant communities.

4. Maintain or improve shrub scrub habitat for resident and migratory avian species.
5. Maintain Mixed Maritime Forest to provide for quality wildlife habitat and visitor experiences.

### **Prescribed Fire Objectives**

1. Reduce hazardous fuel loading thru consumption of >70% of 1 hour fuels and >60% of 10 hour fuels within each burn unit.
2. Reintroduce fire disturbance regime into all appropriate vegetative communities in the park.
3. Top kill 50-75% woody brush vegetation in marsh habitats.
4. Reduce live and dead fuel loading by 50-80% in the shrub-scrub habitat.

## **Review of 2012 Projects**

### **Unit 1.5 (660 acres)**

On February 3<sup>rd</sup> of 2012, the prescribed burn of Bodie Island unit 1.5 was conducted. This burn was significant as a reinvigoration of a fire program that had not burned since the early 1990's and the project was deemed a success by CAHA administration.

The objectives of the burn were two-fold and complex. With all the Bodie Island units so close to the major tourist destination city of Nags Head, N.C. and the increased shrub component due to lack of dynamic over-wash, reducing hazardous fuels is the obvious objective. The second objective is to use fire to replace the over-wash disturbance regime and re-establish marsh vegetation.

Having the correct weather pattern (Northeast wind) was critical to having a successful and safe burn. The CUGA WFM, with the help of the Southeast Regional fuels helicopter, regional Fuels staff, and park staff conducted the operation as an introduction to a new fuel model. The burn began as a black-line operation from the Southwest corner and the Northwest corner until a safe control line was established then the helicopter began ignition in a random pattern working from Southwest to Northeast having moderate success in wet areas with Black-needle rush except for when head-fire ran into these areas. Note also Moderate to High success in *Phragmites* areas/ Xeric-Mesic Shrub areas. A combination of head-fire and flanking/backing fire were used coinciding with dot ignition from the PSD machine inside the helicopter. The burn was definitely a mosaic pattern with varying intensity and severity. The salt-stressed shrub areas burned with considerable intensity especially when adjacent to the High Marsh vegetation. Stands of *Phragmites australis* also burned with considerable intensity. Winds remained favorable, and smoke issues were never a concern.

Post burn fire effects observed from an aerial reconnaissance of the Unit showed that approximately 85% of the unit burned (**Figure 1**). Three small sections of black needle rush located on the south end of the unit did not burn. Sections of the Yaupon/wax myrtle component burned completely and reduced the woody vegetation by 35-60% throughout the entire unit. Fire consumed an estimated 60% litter in Maritime or Loblolly pines along the lighthouse road, but dense shading at this site did not allow for complete litter consumption.

**Figure 1.** Unit 1.5 Post-burn coverage



During the days leading up to the burn, a monitoring design and methods were developed for CAHA, and 13 long-term photo-monitoring points were established in unit 1.5. The points were subjectively placed to represent dominant vegetation and fuels. Points were monumented with galvanized conduit, and a random azimuth was assigned to each point. Four photos were taken at a 90 degrees angle of the preceding photo, and photos were taken Preburn and Immediately post-burn. CAHA Resource Management staff re-took all photos during summer 2012 for a 01yr01 read. **Figures 2** and **3** provide an example of the general fuels reduction that occurred throughout the unit.

**Figure 2.** Photo-point 2 (13°) - Preburn



**Figure 3.** Photo-point 2 (13°) – Year 1 Post



## Resource Notes

The Bodie island lighthouse Burn Unit 1.5 has 2 species located inside the unit that are considered by the North Carolina State Heritage Program to be State Rare and critically imperiled in the state of North Carolina (below). These areas were secured by fire personnel to limit no net loss would occur to these species.

|                  |                              |                       |
|------------------|------------------------------|-----------------------|
| Beaked spikerush | <i>Eleocharis rostellata</i> | NC Significantly rare |
| Marsh spikerush  | <i>Eleocharis halophila</i>  | NC Significantly rare |

It is recommended to monitor these species occurrences to detect negative impacts due to spread of *Phragmites australis*, an aggressive exotic grass whose range is expanding. CAHA currently has only limited ability to treat this species with herbicide.

The “brackish-freshwater marsh” and pond located northeast of the lighthouse is of significant concern to migratory water birds and is considered a Birding World Heritage site. Also, a Black-crowned Night Heron rookery is located in the cedar shrub areas adjacent to the parking lot of Coast Guard Station/Fishing Boat launch area on the South end of the unit. Coincidentally, park visitors were conducting a count of this species while the burn was being implemented.

### Unit 1.4 (660 acres)

The vegetation in this unit is dominated by open marsh, except along the northern boundary (Firing Range road). Between the actual firing range and the Roanoke Sound, there is a large area of old dunes with much more pronounced topography. This area is characterized by barren sand and stunted loblolly pine and live oak. Parts of this area are considered part of a Dune-Heather Barren community, which occurs here in the southern-most part of its range. This community provides habitat for two North Carolina State Rare plants, Beach Dune Heather (*Hudsonia tomentosa*) and maritime pinweed (*Lechea maritime* var. *virginica*). Although loblolly pine is encroaching here, there is not a continuous fuel bed to carry fire under normal conditions. Since these species occur at the northern boundary of the unit along a dune system that travels to west to the water, it was recommended to minimize fire operation activities in these locations. (The use of fire in this community was discussed with Mike Schafale, North Carolina Natural Heritage Program Ecologist, and he thought there would be no negative impact. Although it should be noted that operational activities may have impacted them through ground disturbance.)

Unit 1.4 was ignited on February 7, 2012 with the same ignition plan of black-line against northeast wind and use helicopter ignition for interior. A combination of head-fire and flanking/backing fire were used coinciding with dot ignition from the PSD machine inside the helicopter. The previous night provided anywhere from .10” -.50” of rain across the unit. With that said, this unit burned considerably lighter on the severity scale due to recent precipitation. It still met the immediate objectives and covered 75% of the unit with varying severity. Winds remained favorable, and smoke was never a concern.

As far as the shrub reduction objective, a quick post-fire recon indicated that maybe 20-30% of the wax myrtle and yaupon were top-killed or killed by the burn. One caveat to note is that the

recent hurricane had a significant impact on shrubs in the saltmarsh, which was not totally recognized at the time of the burn. The salt spray and saltwater intrusion undoubtedly contributed to the overall impacts to shrubs in the unit. There were two photo-points installed in the Dune Heather Barren portion of the unit and these areas did not burn, as documented in the photos below (**Figures 4** and **5**).

**Figure 4.** Photo-point 14 – **Immediate Post**



**Figure 5.** Photo-point 14 – **Year 1 Post**



### **Long Term Monitoring Results**

As the monitoring program at CAHA just began in 2012, there are no long-term data to discuss. Short term results of the photo-monitoring are discussed in the Project Reports for Units 1.4 and 1.5 above. As monitoring protocols are implemented over the course of several years, there should be results from photo-monitoring, species cover data, and burn severity mapping that can help determine if objectives are being met, and to ensure that negative outcomes are minimized.

### **Discussion**

Again, with this very young program there is not too much to discuss at this time. Efforts over the coming year will focus on participating in all prescribed burns, continuing to work with CAHA staff on data collection, creating a fire effects database, and documenting monitoring protocols.

# Congaree National Park (CONG): 2012 Fire Effects Monitoring Annual Report

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## Activity Summary

The monitoring crew made three trips to CONG during 2012. In addition to contributing to the successful completion of two significant burns, the crew returned twice to conduct post-burn monitoring, long-term monitoring, and overall qualitative assessments for both burns. The burns of 2012 were quite notable in their coverage of the targeted areas and for the excellent intensity that was observed. The burn of the RCW unit, in particular, was also remarkable because of the rare spread of fire through the Bluff and into the floodplain forest. A detailed account of those burns and the associated monitoring can be found below in this report.

The crew completed all scheduled long-term monitoring plot visits in 2012, although data was not collected in one plot (PITA8, Red Bluff unit) due to the large number of newly created snags. Interestingly, those snags did not appear to have died as a result of fire, but rather could be due to southern pine-beetle activity. This is not confirmed. Notably, both immediate post-burn reads and long-term monitoring reads were conducted for every plot at CONG (other than PITA8). This allowed an interesting analysis of sweetgum stem densities. Please see the Long Term Monitoring Results section of this report. Aside from completing the large amount of plot-work, the crew was also able to spend time scouting the sections of the Bluff and floodplain forest that were burned during the RCW prescribed burn.

The fire ecologist made just a single visit to CONG during 2012 to participate in the prescribed burns in March. Serving as the FEMO trainer allowed for the close monitoring and documentation of fire activity in the longleaf pine stands of RCW as well as in the Bluff and swamp edge. Selected photos from that work are featured in the account of this year's burns. (Note: I also failed miserably as a trainer and did not get FEMO reports of these consequential burns from my trainees – hopefully the accounts below will serve as adequate documentation of these events). Finally, other work for CONG this year focused on requesting and interpreting landscape burn severity images for this year's burns, and directing the construction of the fire history database.

## Program Goals and Objectives

In past years' reports, we've used this space to communicate existing goals and objectives and to improve the objectives as new data have become available. The only notable change to the existing objectives may pertain to the protection of sensitive hardwoods and old-growth loblolly pines that are found in the bluff and along the edge of the floodplain forest. However, the actual objectives to reflect these resource values have not been fully discussed or finalized; this will be a goal for the coming year. The account of this year's prescribed burns describes the rare spread

of fire through this bluff and swamp-edge habitat, and the monitoring of the associated impacts. Continued monitoring efforts should help guide the development of appropriate objectives.

Until such time as the objectives are updated, the reader is referred to last year's report for a review of the prescribed fire objectives at Congaree. That report can be found at the SER Fire Sharepoint web site.

## Review of 2012 Projects



Baptisia sp. in post-fire bloom –  
Harry Hampton

The 2012 prescribed fire season at Congaree National Park was very productive. The scheduled burns of RCW/ Harry Hampton V.C. and Red Bluff/ Dawson's Cabin were completed with much success and within a short period of time.

No Fire Effects Monitoring (FEMO) reports were written for the following projects at the time of the burn, so this document will serve both as FEMO report and year-end project review. Information described in the following document was obtained from discussions and notes from the FEMO, discussions with the Burn Boss, and 2 separate site visits with field reconnaissance of the units. Prescribed fire was conducted by CUGA WFM, GRSM WFM, CONG staff, KIMO staff, and GRSM FET.

### **RCW/Harry Hampton V.C. (projected acres: 560 acres - actual acres burned: 635 acres):**

On March 14<sup>th</sup>, 2012, the 7<sup>th</sup> prescribed burn was conducted in the RCW unit of the Park and the 5<sup>th</sup> for the Harry Hampton Visitor Center. The site is comprised mainly of loblolly pine forest, but also contains a large stand of high quality longleaf pine woodland along with more minor components of oak/hardwoods, bluff vegetation and floodplain forest near the southern edge. Fuels are complex throughout these two units and are comprised mostly of pine litter that is mixed with grass/herbs in the RCW section.

#### **Burn Day Observations**

Projected weather for the burn day was: high temperature of 83° F, low rH at 36%, and winds were predicted out of the west and southwest between 2-5 mph. There was little weather data recorded from day of the burn, but as per Rob Klein, the observed weather was very similar to that predicted.

The ignition plan for the event divided resources into two divisions: Division A fired between the South /Eastern edge of the unit and west to Caroline Sims Road with black-line strip ignition along the road (1, 2, 3 or 3, 2, 1 depending on wind direction) and dot technique on the interior; Division B fired from Caroline Sims road and West/North into Harry Hampton/ VC unit occupying both sides of main park drive. It was unclear what firing technique was used in Bravo's operation.

Ignitions began at the test fire site near the Science Center with an inversion still in place at 1100, and in a fairly closed canopy of loblolly pine. Early on, flame lengths in shaded pine litter were approximately 1 foot on average, and producing about 70% consumption. At 1140, ignition was started in the southeast corner of the RCW burn unit under heavy clouds and light fog; fire behavior was minimal in hardwood litter but carried well in pine litter. At 1200, the cloud cover lifted and fire behavior picked up in the light and flashy fuels. Temperature at this time was recorded at 67 and fire behavior was recorded at a rate of spread (ROS) in between 5-10 chains/hour. Consumption of litter and light fuels was estimated to be around 75% and smoldering spots of litter and upper duff were noticed. Early ignition was thought to have good effects on smaller saplings of Sweetgum (*Liquidambar styraciflua*) and wax myrtle (*Morella cerifera*).

As the ignition progressed and the daily temperatures rose, rH dropped and winds increased, instances of increased fire behavior were observed. Mild wind gusts produced head fires with flame lengths of 4-10 feet moving at a rate-of-spread of 10 chains-per-hour were observed in the interior of the burn near Garrick Road. At 1600 it was noted by the FEMO that fire had moved uniformly to the bluff edge, burning through hardwood litter, grass, mixed pine/hardwood litter, cane, and under dense stands of Sweet-gum saplings. It would also be of note that occasional torching of Wax Myrtle was seen. Typical fire behavior alternated between head fire pushes with 3-5' FL and backing fires 6"-1' FL. The following are images of typical fire behavior.



**Typical backing fire behavior in open pine – RCW**



**More active fire under Wax-Myrtle - RCW**

Approximately due south of Garrick Road, the FEMO observed fire out beyond the bluff edge that continued to carry through the swamp edge where grass fuels and continuous hardwood litter were present. Fire burning through the bluff and into the swamp is of great interest and is discussed later in the “**Discussion**” portion of the report. The photo below documented the observed fire behavior.

There was no fire behavior information recorded for Division Bravo (Harry Hampton VC), although it was noticed while fire effects crews were completing post burn FMH plot reads, that fire behavior and intensity may have been a slightly higher in this area due to ignition during the peak of the burning period. This effect was observed post burn and interpreted from char heights of overstory loblolly pines and pockets of crown scorch on overstory and pole sized trees, but was limited to small portions of the overall burn unit. These areas can be seen on the Severity map (**Figure 2**) as low-moderate severity (light blue).



**Fire backing into the swamp edge through previously fire damaged Sweetgum and cane - RCW unit**

### Fire Effects

All 8 fire effects plots burned completely except PIPA 01, which had a small unburned portion due to its location within a fairly wet area surrounded by sweetgum and Willow oak. Fuels data for any single burn are difficult to interpret because of time constraints and a sampling schedule that don't allow for collection of fuels data immediately prior to each burn. Low plot numbers and variability in fuel type are further complications to using these data. However, we can say from our postburn data that litter fuels seem to have been uniformly reduced by this burn, and the severity on the forest substrate consistently rated in the "light burn-scorch" category (**Table 1**). These are fairly typical values for CONG, and the take-home message is that the burn consumed a high percentage (but not all) of the fine fuels over much of the unit. Data for total fuel loading indicates that there has been a solid reduction of total fuels in these units since fire effects monitoring was initiated (1998 for RCW plots, 2002 for Harry Hampton). Plot PIPA05 was not established until 2006, and so was excluded from the total fuels analysis.

**Table 1.** Post-burn severity and fuel reduction for RCW/Harry Hampton monitoring plots.

| Plot   | Burn Unit     | Substrate Severity Rating* | Post-Burn Litter Depth (inches)** | Total Fuel Load - Change from Pre-burn |
|--------|---------------|----------------------------|-----------------------------------|----------------------------------------|
| PIPA01 | RCW           | 3.5                        | 0.1                               | -35%                                   |
| PIPA02 | RCW           | 3.9                        | 0.3                               | -27%                                   |
| PIPA03 | RCW           | 3.7                        | 0.3                               | -54%                                   |
| PIPA04 | RCW           | 3.8                        | 0.2                               | No change                              |
| PIPA05 | RCW           | 3.9                        | 0.3                               | n/a                                    |
| PITA10 | Harry Hampton | 3.6                        | 0.3                               | -42%                                   |
| PITA11 | Harry Hampton | 3.7                        | 0.4                               | -50%                                   |
| PITA12 | Harry Hampton | 3.7                        | 0.3                               | -24%                                   |

\* A rating score of 3.0 = light burn (litter almost completely consumed), 4.0 = scorch (litter partially consumed)

\*\* The original pre-burn litter depth in these plots averaged about 2"

Additional insights into fire effects can be gained from copious observations that were made by the fire effects crew while conducting qualitative surveys of the burned area:

- RCW/HH Units are in a maintenance phase in terms of fuel loading and the 2012 prescribed burns perpetuated the maintenance of the fuel loading

- Overall severity of the unit was observed to be similar to the plot ratings (Scorch/Light Burn)
- More than the usual number of 1000 hour fuels was reduced to ash after smoldering for several days post burn. The duff immediately surrounding these 1000 hour fuels was also reduced to mineral soil
- Top kill of sweetgum and other hardwoods was high among individuals that were within the 0-6 foot range. In general, individuals taller than 6 feet remained alive
- Another significant note is that the fire burned beyond the upland pine forests and the historical burn boundaries (**Figure 1**). The additional burned area was mostly grassy fuels and mixed pine savanna, which burned with low intensity, but fire also fingered into the floodplain forest with relatively low intensity and severity (**Figure 2**)
- The final burned acreage was 75 acres more than expected
- One discovery on the day of the burn was that a large loblolly pine with a pre-existing catface (see picture for example) became ignited and was unable to be put out with available water. The tree fell but was not a threat to the control line and fire spread was very minimal
- Upwards of six mature loblolly pines were killed outside the historical RCW unit boundary from fire intrusion in basal scars and their subsequent falling over. The locations for these fire-killed trees were recorded with GPS
- Of the six loblolly trees that fell, it was noted that they existed within larger stands of surviving mature loblolly
- In general, the surrounding hardwoods below the bluff had no major effect from the fire except for one small 10 x10 m area where torching occurred. **Figure 2** depicts the overall severity of the burn based on Landsat image analysis
- Small pockets of light/moderate severity were observed in the VC unit; these areas featured significant crown scorch but no overstory mortality (**Figure 2**).



**Burned longleaf pine sapling with protected terminal bud.**

**Figure 1. Map depicting historical burn unit boundaries (“Planned”) and the actual perimeter of the 2012 prescribed burn.**

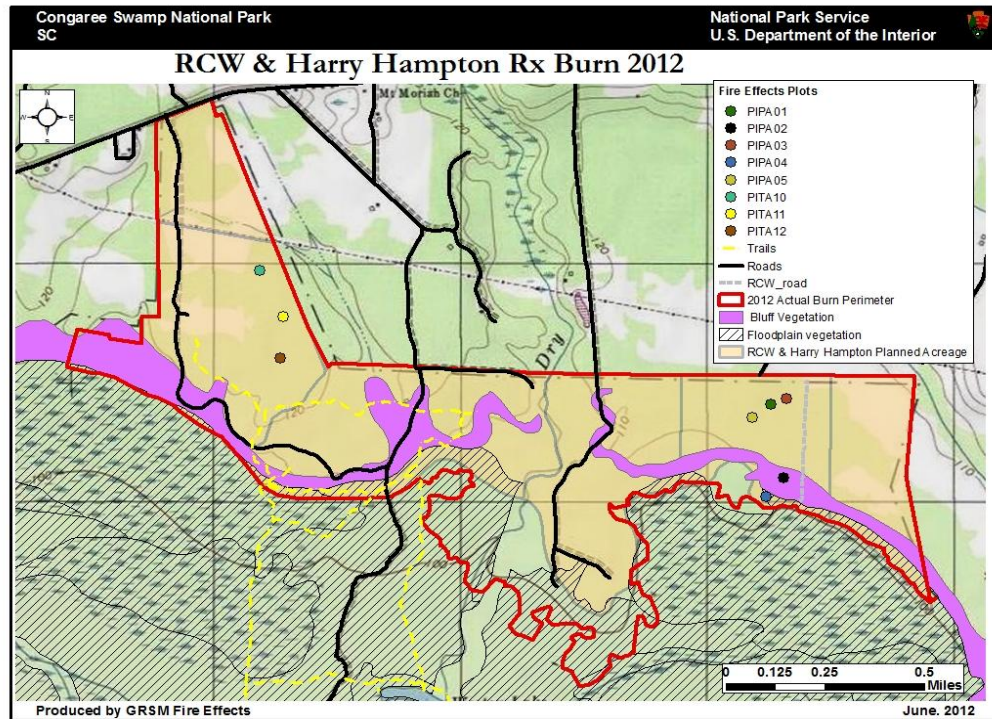
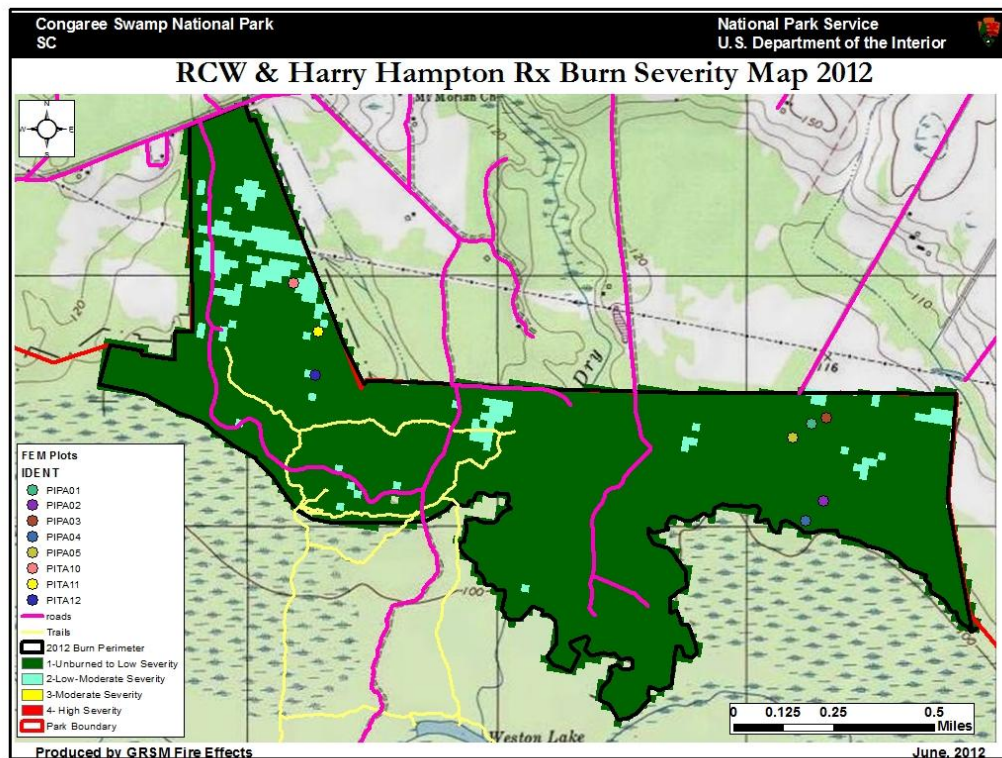


**Figure 2. Landsat-based severity (dNBR) map of 2012 RCW/Harry Hampton prescribed burn.**  
Note the unburned/low severity of the burn in the floodplain forest and areas south of the Bluff.



### Discussion and Recommendations:

The outcome of the RCW/H.H. Visitor Center burns was a positive step in fuels management and habitat restoration at Congaree National Park. The burns had minimal impact on the pine overstory, but this solid understory burn was much needed after 6 years since an effectual burn. A large number of sweetgum and other undesirable hardwoods were top-killed in the sapling size class. With continued 1-3 year burning rotation, the maintenance of the fuels will continue and reduction of the number of sweet gum stems should be furthered.

In regards to the fire burning beyond what is considered the bluff edge or historic unit boundaries, it might be wise to reassess what the boundaries actually are in reference to vegetation present. To note, in previous years, there is evidence of fires traveling beyond the expected boundaries, largely following pine fuels and vegetation, and extinguished once in the bottomland. Although 2012 appeared to be a severely dry year, it should be noted that even under these conditions, only a very low intensity-low severity fire traveled past the drawn boundaries. The fire appeared to have crept and backed along fingers of mixed pine-savannah vegetation and briefly into floodplain forests.

CONG staff and Fire Effects crew members observed several large fallen loblolly pine trees scattered along the burn perimeter, layered among other large Loblolly pines similar in size. Compared to the number of other standing, similarly sized Loblolly pines, this effect is interesting from an ecological perspective, but relatively minor in terms of effect on the resources. In fact, it may be that canopy gap creation during infrequent fires like these historically played a role in regeneration of Loblollies in this habitat.

Fire-spread into the actual floodplain forest during prescribed burn events is probably a rare event, but is a cause for concern. Ideally, fires should not be allowed to spread into this habitat type on a frequent basis, and it is expected that soil moisture will typically work to regulate this occurrence. Two possibilities for predicting the likelihood of such an event are to calibrate past fire activity to the USGS water level data for Cedar Creek and/or to Keetch-Byrum Drought Index (KBDI) values generated by the CONG RAWs station. For starters, observed values could be compared to that of 2012 as a baseline for when fires might travel beyond expected boundaries. Also, since 2012 levels were indicative of very dry conditions, it may help to investigate past years that were burned during the same conditions to note possible similar fire spread.

On a final note, our field observations suggest that the most serious detriment to the resources at CONG is the severe ground disturbance from wild hog damage. After a few scouting missions, hog wallows, sow and shoats and boars were seen feeding on the emerging vegetation following the burn. They have been observed in the core Long leaf pine stand turning over soil where the most pristine herb layer in this community remains. They were widespread in both RCW and Red Bluff burn units. Another part of the fire-floodplain puzzle that most likely relates to the hog damage is the presence of Japanese stiltgrass (*Microstegium vimineum*) where the rooting occurred. It has also been noticed in light gaps of early successional forest areas of the main finger of mixed pine-savannah vegetation of RCW.

### **Red Bluff/Dawson Cabin Project (389 acres):**

Red Bluff (192 ac) and Dawson's Cabin (197 ac) are 2 adjacent burn units located on the park boundary along Red Bluff Road off of South Cedar Creek Road. The first entry burn into these Units was conducted on March 29, 2007 with very light and spotty results due to heavy cloud cover, high humidity, and afternoon rain showers. The second entry burn into these occurred on April 7<sup>th</sup>, 2010 with better results and wider coverage. On March 15-16, 2012, the 3<sup>rd</sup> prescribed burn for those 2 units was conducted.

The site is mostly comprised of loblolly pine plantation flats with very little herbaceous cover and successional vegetation surrounding old Homesteads. Small depressions of hardwood islands exist throughout the unit. Along the southern end of the unit lies a very noticeable bluff edge. In the East the transition is from loblolly pine to water tupelo and mixed bottomland hardwoods. The West end the bluff edge is dominated by upper bottomland hardwoods such as Beech and water oak. Dominant fuels were mostly pine needle litter.

### **Burn Day Observations**

Again, no FEMO report was completed for this burn, so this section of the annual report will serve as the FEMO report. No fire behavior data exists for this burn but it is assumed by looking at the Severity Map (**Figure 3**), that fire behavior was fairly low in intensity.

Spot forecast weather predicted high temperature of 86 F at 1700 with a low rH of 28%, winds out of the southwest 2-5 (10) mph. Observed values were similar to the spot forecast except at 1400 cloud cover increased to 50% and precipitation fell in a scattered pattern over the burn unit.

Ignition patterns and techniques were the same for this day with squads using 3, 2, 1 pattern to build depth for black line operations and dot patterns combined with strip ignition to create intensity when needed. There was an Alpha and Bravo firing and holding division with a test fire starting at the center of the unit. Alpha fired around old cabin site and proceeded black line operations to the west at approximately 1300. At the same time Bravo fired along the Northern boundary of the unit using the same techniques to the East. By 1400 Alpha had completed firing to the west and light precipitation began to fall on the unit. Bravo fired as far East as possible, when ***precipitation shut the burn down for the day***, but not without several more unsuccessful attempts that day. The following day, March 16<sup>th</sup>, after discussion with CONG resource staff, the Burn Boss decided to re-ignite unburned portions of the unit with 2 squads of rogue igniters. Ignition lasted until the remainder of the unit was successfully ignited and objectives were achieved.

Further discussions about fire effects with Burn Boss trainee, Sasha Ernst, indicated that ignition and fire behavior re-established well in previously thinned pockets of loblolly approximately ½ acre in size. These areas were identified by CONG park staff as an area for the CUGA-WFM to thin and open the understory. It was noted by the Firing Boss that, fire burned in the cured pockets of thinned loblolly “really well”, especially in areas that received no fire the day before and slight precipitation.

### **Fire Effects**

Immediate Post burn observations indicated very few high severity areas, and several small pockets of low-moderate severity fire that mostly stayed above the bluff or fingered over slightly. Because these units have a more defined bluff edge, fire generally backed off the bluff with little intensity to the toe of the slope and went out.

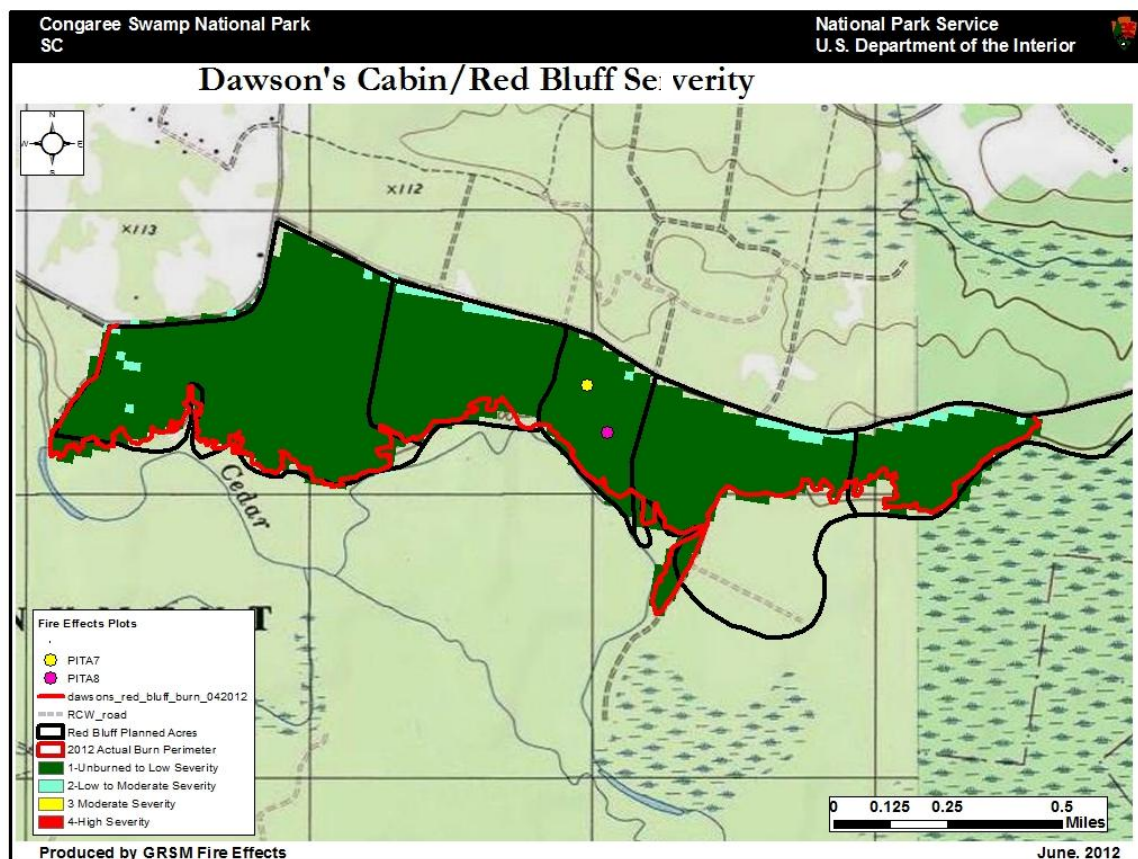
Litter consumption and hardwood top-kill objectives appeared to have been met after reconnaissance during immediate post-burn data collection. The two fire effects plots in the unit burned completely. One remained difficult to read because a recent snag patch, thought to be Southern Pine Beetle, existed in the center. Other observations included:

- Fuels in this unit are also in a maintenance phase and the 2012 burn perpetuated this
- Fire behavior was moderated by increased humidity and precipitation
- North boundary where fuels were slightly unshaded and wind could move fire efficiently, severity was low –moderate ( light blue sections on **Figure 3**)
- In general, fire did not move below the bluff and into the floodplain
- Adding 1 operational period helped achieve objectives after precipitation

### Discussion

In general, the burn appears to have been a good understory burn with low severity. With the increase in light to the forest floor and continued rotational burning, the sweet-gum should be reduced and herb diversity will increase. As stated in the above section, fuels appear to be in a maintenance phase and continual burning on an average of 1-3 years will keep fuel loading to a minimum. Analysis of post burn data was not done to only 1 plot being represented

**Figure 3.** Landsat-based severity (dNBR) map of 2012 Red Bluff/Dawson's Cabin prescribed burn. Note that the uniform low severity typically indicates either unburned conditions or, as in this case, a solid understory burn with little to no impact to the canopy.



## Long Term Monitoring Results

There has been no update to the standard analysis of long-term monitoring results (FMH protocols); our time was instead used to provide a thorough analysis of the most recent prescribed burns. Consequently, **Table 2** has not been updated for this report, though we include it below as a reference point for reviewing the progress toward achieving program objectives. As noted in previous years, the results from CONG do not accurately represent the status and trends observed in the core longleaf area. However, the collective results are a good example of the trends in the more abundant loblolly pine forest type, and those results suggest that CONG is making reasonable progress in the long-term process of converting the dense loblolly forest into more of an open woodland structure characterized by lighter fuels. Further discussion regarding the results of **Table 2** can be found in last year's report.

**Table 2.** Objectives and long-term monitoring results for CONG

| Vegetation Type                                                                    | Management Objective<br>Restoration Phase-<br>After ?? burns | Monitoring Results<br>(80% confidence intervals)                                                                                 | Objective Achieved? | Year Last Analysis Completed |
|------------------------------------------------------------------------------------|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------------|
| <b>Longleaf/<br/>Loblolly Pine<br/>Woodland<br/>(FPIPA1)</b><br><br><i>5 plots</i> | >50% Reduction in total fuel loading                         | Fuel reduction after 6 burns: 18%<br>( <i>n=4 plots, 1 burn unit</i> )                                                           | <b>No</b>           | <b>2008</b>                  |
|                                                                                    | 15-30% Reduction in overstory tree density                   | Overstory reduction after 5 burns: 4%<br>( <i>n=4 plots, 1 burn unit</i> )                                                       | <b>No</b>           | <b>2008</b>                  |
|                                                                                    | >200 tall (>1m) Longleaf pine seedlings /ac                  | Preburn density: data not clean<br>After 5 burns: 0<br>( <i>n=4 plots, 1 burn unit</i> )                                         | <b>No*</b>          | <b>2008</b>                  |
| <b>Loblolly Pine<br/>Forest<br/>(FPITA1)</b><br><br><i>5 plots</i>                 | >50% Reduction in total fuel loading                         | Total fuel reduction = 38%<br>Preburn avg.: 33.0 tons/acre<br>After 3 burns: 20.6 tons/acre<br>( <i>n=3 plots, 1 burn unit</i> ) | <b>No</b>           | <b>2008</b>                  |
|                                                                                    | >70% Reduction in pole-sized tree density                    | Pole reduction:<br>After 1 burn: 38%<br>After 2 burns: 46%<br>After 3 burns: 65%<br>( <i>n=3 plots, 1 burn unit</i> )            | <b>No</b>           | <b>2008</b>                  |
|                                                                                    | 25-50% Reduction in overstory tree density                   | Overstory reduction:<br>After 1 burn: 3%<br>After 2 burns: 3%<br>After 3 burns: 8%<br>( <i>n=3 plots, 1 burn unit</i> )          | <b>No</b>           | <b>2008</b>                  |

### Additional Analyses

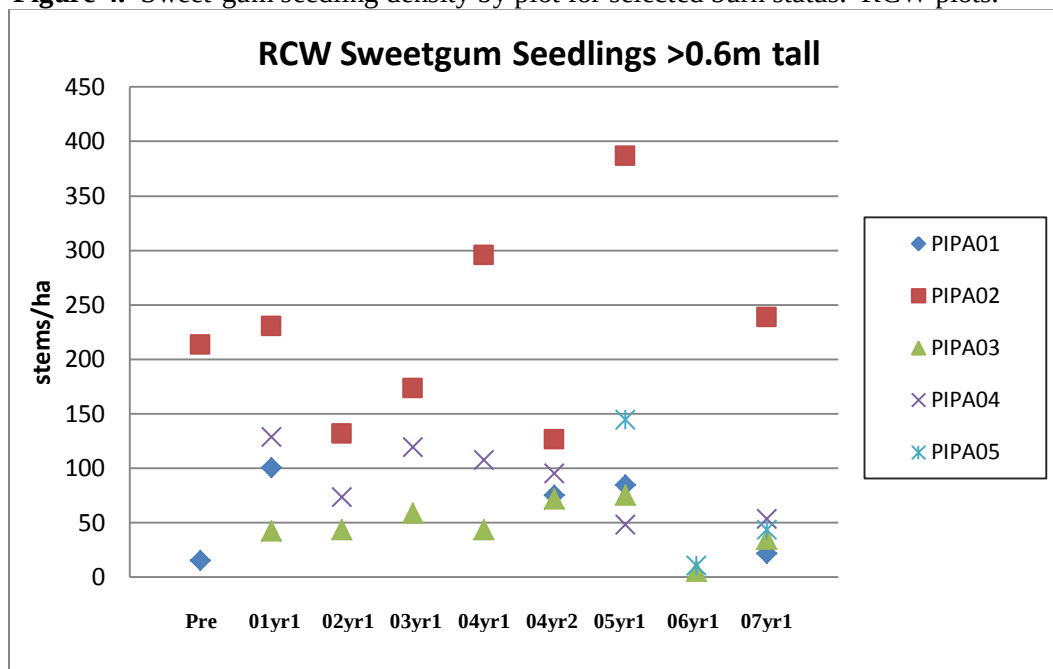
There is a wealth of additional data from our long-term FMH monitoring that can be used to explore various aspects of fire-effects at CONG. Recognizing that the table of long-term monitoring data (**Table 2** above) only addresses the results from a limited number of variables, this year we have conducted additional analyses that may provide more insight into the status and trends for a variable that has become increasingly important over the past 4 years – the abundance of sweet-gum in the pine forest understory.

In last year's annual report, we discussed the development of a thick sweet-gum cohort in the understory of the RCW area, and subsequent visits have revealed a similar, if younger, cohort

forming in the loblolly pine forest of the Red Bluff and Dawson's Cabin burn sites. This thick growth of sweet-gum already dominates the understory in sizable portions of the RCW burn site, and if left unchecked, could seriously limit our ability to achieve other ecological goals. Control of these sweet-gum cohorts has become a primary objective of the prescribed burn program, so in this year's report, we wanted to look at the plot data from across the park's burn sites to see what we could learn about the current status, and determine if the trends could provide any insights about control of this species with fire.

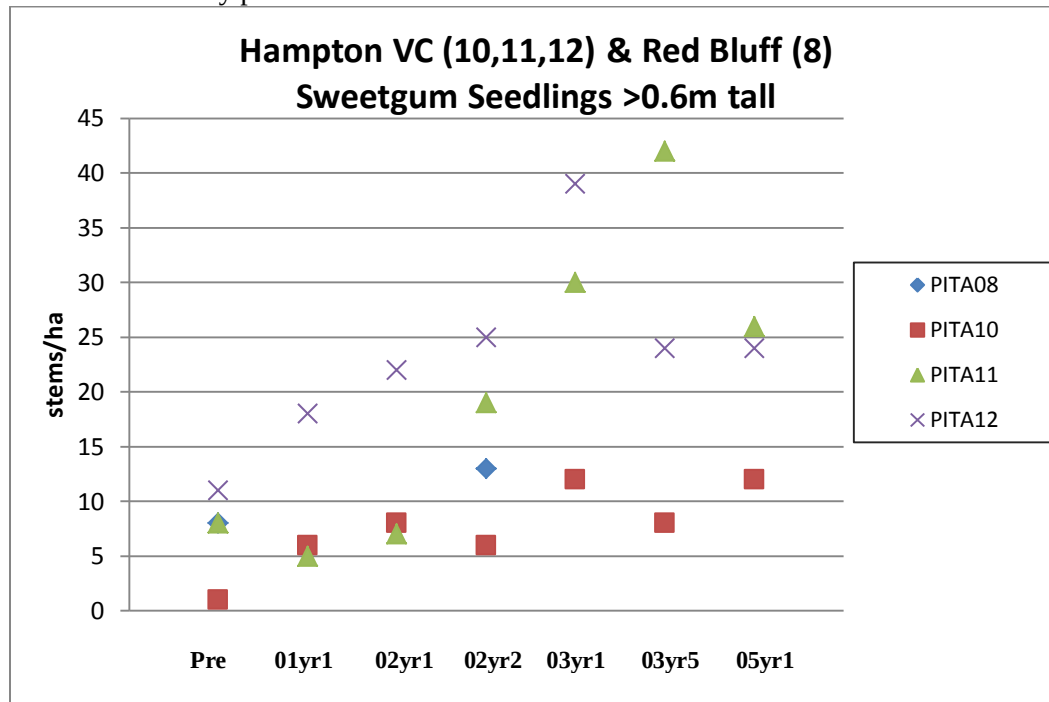
**Figures 4** through **7** below provide estimates for sweet-gum density in the understory and midstory of upland pine forests at CONG. **Figures 4** and **5** give estimates for the number of sweet-gum seedlings per hectare at different times before and after burning. Seedlings are defined here as understory trees that are <2.5cm dbh and >0.6m tall. **Figures 6** and **7** estimate the number of pole-sized sweet-gum (>2.5cm dbh and < 15cm dbh) at various burn status. Data are grouped by vegetation type, with plots in the loblolly-longleaf woodland of RCW shown together, and plots in the successional loblolly pine forests of Harry Hampton and Red Bluff shown together. Each chart is simply followed by a series of bullet points that highlight some of the information represented by each. It is important to state clearly that each of these points is based on data from a single plot and indicates no statistical confidence.

**Figure 4.** Sweet-gum seedling density by plot for selected burn status. RCW plots.



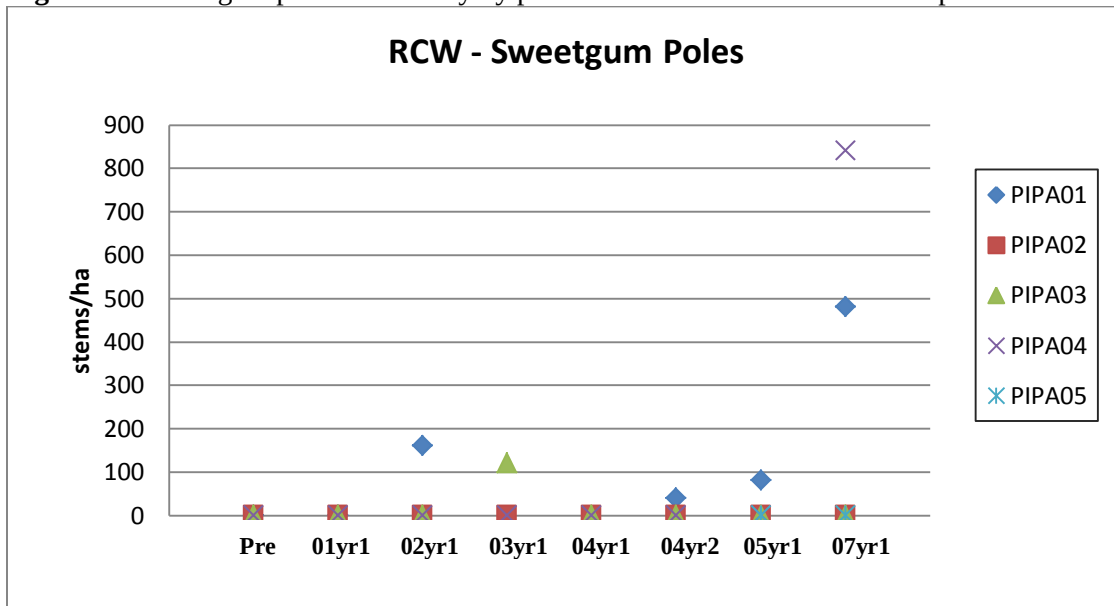
- Labels on the X axis represent burn status; ex. 01yr1 is first growing season after the first burn
- This chart reveals the consistent and current modest density of small sweet-gum saplings in most plots at RCW. PIPA02 is the exception, with much larger numbers of sweet-gum stems. The trend indicates that overall numbers have not changed much in these plots over the past 13 years.
- **Figure 1** in the RCW burn report provides a look at the geographic distribution of these plots.
- Note that PIPA02 lies very close to the bluff, in an area that has not burned consistently well over the years – ensuring that we achieve good burn coverage with future burns is key to controlling sweet-gum in this problematic area.

**Figure 5.** Sweet-gum seedling density by plot for selected burn status. Successional loblolly pine forest.



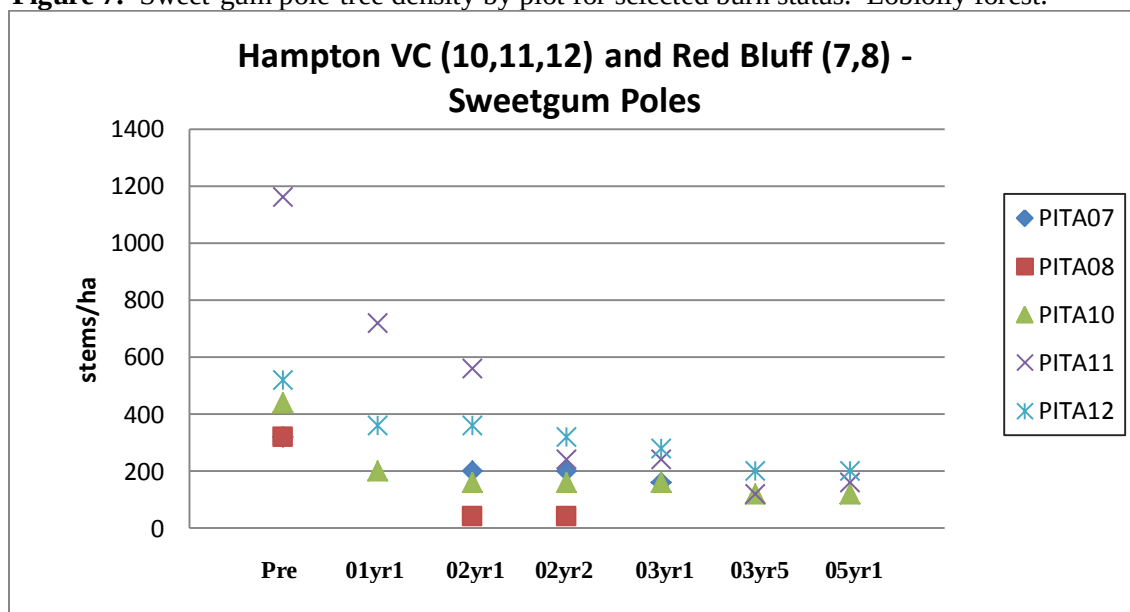
- Two things jump out here: 1) overall numbers are very low and 2) the trend indicates increasing stem densities, even after multiple burns
- It's likely that this trend simply reflects the ability of sweet-gum to resprout prolifically following prescribed burns
- Differences in trends between these plots and those in RCW (increasing vs. steady) may reflect differences in understory competition between these veg types, with less competition in the successional pine understory

**Figure 6.** Sweet-gum pole-tree density by plot for selected burn status. RCW plots.



- There were several burns in this area prior to our “pre” burn plot installation in 1998, so this does not represent an accurate baseline
- Low numbers of these larger sweet-gum trees indicates that the fire regime of the past 20 years has been successful at preventing recruitment in some parts of RCW
- Big recent increases in PIPA04 and PIPA01 suggest that rapid recruitment has occurred over the past 6 years in some areas
- Both of these plots occur in wetter-than-average microhabitats of the RCW unit that, prior to last spring, had not burned effectively since 2006
- The fact that these trees were still alive at 07yr1 (following last spring’s good burn) is indicative that once sweet-gum achieve this size, they may be difficult to control with fire in these wetter sites.

**Figure 7.** Sweet-gum pole-tree density by plot for selected burn status. Loblolly forest.



- This graph presents a more accurate baseline than **Figure 6**, and may illustrate what happened in RCW following the earliest burns in the late 1980’s/early1990’s
- This is a hopeful graphic that seems to suggest that even larger sweet-gum may be top-killed by fire in drier sites
- Seedling data from these same plots (**Figure 5**) are indicative of the resprouting ability of sweet-gum, and the need to continue burning to control it.

## Discussion

Overall, it was a very successful year for prescribed burning at CONG. Most of the park-wide acreage currently being managed with fire (all except Griffin's Creek) was burned very effectively. Most importantly, the RCW/Harry Hampton VC units, which had not been burned effectively since 2006, experienced a very complete and effective return of fire. During those six years when much of the RCW area received no effective burning, a dense cohort of sweet-gum developed throughout large portions of the unit. Analysis of sweet-gum stem density in long-term monitoring plots (**Figures 4 and 6**) reflects what is readily observed, but the lack of similar increases in several plots suggests that sweet-gum has been favored to a much greater extent in moister microsites and in areas that are closer to the Bluff edge. One explanation for this is that, even in 2006 and years prior, those are the areas that have burned in a patchier manner.

This year's burn was effective at reducing the smaller size class of the sweet-gum cohort (those < 7 feet tall), but did not effectively control the larger size class. It continues to be important to burn this area frequently (2-3 years), but attention should also be given to ensure that there is adequate fuel loading in the deeper sections of the unit to support complete fire spread throughout dense stands of sweet-gum. These areas contain less grassy fuel and will require 2-3 years to achieve sufficient loading of pine litter to accomplish this goal. It may be possible to burn grassier sections of RCW on an annual basis, but if funding is tight it may make more sense to prioritize burning on the 2-3 year interval. A similar interval, coupled with intensive burning, should be effective at achieving fuels and resource goals in areas dominated by successional loblolly pine forest (i.e. Harry Hampton and Red Bluff Units).

The review of this year's burning includes the use of data from remote sensing and on-the ground reconnaissance to evaluate the impacts of fire spread through large sections of the Bluff and into the floodplain forest. These monitoring efforts suggest that relatively little damage was done to the overstory in the mixed hardwood/loblolly pine forests in this area, with the exception of several large loblollies that came down. Longer-term impacts to canopy and effects to the understory are less reliably detected by these monitoring methods, so a monitoring priority for the coming year will be to conduct more detailed assessments in this area.

# Cowpens National Battlefield (COWP): 2012 Fire Effects Monitoring Annual Report

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## Activity Summary

The monitoring crew made two trips to COWP during 2012, once to participate in the prescribed burn of Loop Project Units 1-4, and then later in the growing season to conduct a qualitative monitoring survey of that same area. A detailed account of that prescribed burn and the associated short-term monitoring can be found below. The Loop Project site contains no permanent monitoring plots, so from a long-term fire-effects monitoring standpoint, there is no new information to report for COWP.

## Program Goals and Objectives

In past years' reports, we've used this space to communicate existing goals and objectives and to develop the objectives as new data have become available. There are no significant changes in goals and objectives for COWP, so in the interest of reducing the length of this report, the reader is referred to last year's report, which can be found on the SER Fire Sharepoint site.

## Review of 2012 Projects

### **Loop Project Units 1-4 (108 acres):**

Units 1-4 occupy roughly the northern half of the area contained within the Tour Loop Road. Collectively, these units contain a mix of grassy and wooded patches, and most of this area has been burned multiple times over the past ten years. The long-term goals for these burn units are: 1) to maintain grass fields, and 2) to create a more open, woodland condition in forested areas. The burn-plan objectives were to:

- Reduce 1-hr fuels by 30-85% over 75% of the burn unit area
- Reduce the density of pole-sized trees (1-6") by 20-80% as measured within 1 year postburn

An additional burn-day objective was to follow the US Fish and Wildlife Service guidelines for management and monitoring of the dwarf-flowered heartleaf (*Hexastylis naniflora*).

The burns were conducted on February 22, on a day that started with heavy cloud cover and high levels of fuel moisture that lingered through mid-day. Conditions were mostly sunny by 1200, and mild winds with moderate gusts helped to dry the fuels and aid in fire spread during the afternoon. The test fire for the Loop Project occurred at 1045, at the northwest corner of Unit 4. Heavy ignition was used during black-lining and interior lighting of Unit 4 due to initially moist

conditions and sparse fuels. Despite the intensive ignition, fire spread remained poor throughout most of Unit 4, and the burn was very patchy due to extensive recent mastication, which generally reduced fire spread and intensity. Qualitative monitoring conducted later during the growing season confirmed that the burn of Unit 4 was very low in severity, and had little impact on midstory and overstory trees.

By 1200, igniters had moved into Unit 3, and fire behavior began to pick up as fuel loading and fuel moisture improved. Even so, the fire intensity was generally low, and most flame lengths remained under 2'. As in Unit 4, masticated areas on the edge of the battlefield had lower fire intensity than similar un-masticated areas, though more continuous oak litter allowed fire to spread evenly through this area. Post-burn monitoring indicated that approximately 75% of understory saplings were top-killed, which is within the desired range. This should help maintain the historical, open-understory appearance and encourage regeneration of oaks.

Burning in the area of Sucks Creek was closely monitored, and a summary of fire behavior and fire effects is included in the Fire Effects Monitoring Report from the day of the burn. Another area of interest in unit 3 was the mature loblolly pine stand along the Loop Road. This area has a substantial amount of sweetgum and loblolly pine in the understory, and had been identified as needing a higher intensity burn to control these woody stems. The ignition team reported good burning in this area, though post-burn monitoring during the growing season revealed spotty top-kill in the thick woody understory, with most stems >2m (6ft) tall surviving the burn. It appears unlikely that the goal for open understory conditions may not be achieved in this area without some kind of manual thinning.

Units 1 and 2 contained much larger proportions of old field habitat, though these areas had mostly been brush-hogged and experienced patchy burns as a result. There are large numbers of the exotic plants Chinese privet and sericea lespedeza in these fields, and it is unlikely that these burns did anything to help control those infestations. The wooded areas within these units seemed to burn reasonably well, though only limited observations were made. The mature island of forest between the Thicketty Mountain parking area and the Green River Road experienced some the most intense and complete burning of the day. This area had a heavier fuel load than any other part of the day's burning, and post-burn monitoring indicated a nice burn that was effective at reducing fine fuels and opening up the understory.

## **Long Term Monitoring Results and Discussion**

There is not much to say about long-term monitoring at COWP at this time. There were no additional plot data collected during 2011, and the existing data come from plots situated in areas where fire has been discontinued. Given the current focus of the prescribed fire program on using fire only inside the area bounded by the Tour Loop Road, the establishment of additional permanent plots to monitor fire effects is not practical. The focus of the monitoring program going forward will be to participate/document the planning and implementation of prescribed burns, and continue to conduct qualitative assessments of burned areas.

# Cumberland Gap National Historic Park (CUGA): 2012 Fire Effects Monitoring Annual Report

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## Activity Summary

The monitoring crew made five trips to CUGA during 2012. In addition to contributing to the successful completion of the Harlan Road, Lewis Hollow, and Campground prescribed burns, additional trips focused on post-burn monitoring of those units. A detailed account of each prescribed burn and the associated monitoring can be found below.

The crew completed all scheduled long-term monitoring plot visits in 2012, though data collection in two of those plots was limited to varying degrees by the presence of hazardous snags. Note that in one of those plots, QUCO13 in Harlan A, those snags did not appear to have died due to direct fire impacts, but rather from some form of oak decline. The current strategy for dealing with hazardous situations like these is to complete as much work as can be safely done, complete a qualitative description of plot condition, and repeat until the plot is safe to work in. Long-term monitoring included work in the Harlan A, Lewis Hollow A, and Campground burn areas.

The fire ecologist made one visit to CUGA during 2012, to help prioritize upcoming projects, review the Harlan Road burn, and meet with the Park Superintendent. Also of interest to CUGA, the ecologist made significant progress on developing and testing a field method to serve as ground-truthing for the remotely-sensed burn severity images (dNBR) that are routinely featured in our annual reports. The discussion of “Alternative Monitoring (Landscape Fire Effects Mapping)” found in the Big South Fork section of this annual report contains a description of this approach and examples of the spatial and tabular data that can be generated from these methods. We currently have such remote-sensing data for several of the past burns at CUGA, and we have the ability to get more. The new field methods should work well at CUGA, and this new monitoring tool is expected to yield important additional information about the prescribed burn program there.

## Program Goals and Objectives

One of the successes of our fire-effects monitoring program has been its contribution to the development of short and long-term objectives for the prescribed fire program. Monitoring data have been continually used to evaluate and improve objectives, and this is indicative of our major advances in understanding Appalachian fire ecology over the past 15 years.

In past years’ reports, we’ve used this space to communicate existing goals and objectives and to improve the objectives as new data have become available. There are no significant changes in goals and objectives for CUGA, so in the interest of reducing the length of this report, the reader is referred to last year’s report, which can be found at the SER Fire Sharepoint site.

## Review of 2012 Projects

### **Lewis Hollow A (106 acres):**

The Lewis Hollow A Rx Burn is located in the rolling foothills below Cumberland Mountain, near the Wilderness Road Campground area of Cumberland Gap National Historic Park in Lee County, VA. The unit is comprised of three knobs primarily dominated by xeric to dry-mesic chestnut oak/scarlet oak forest occasionally mixed with scattered pockets of shortleaf pine and beetle-killed pine on exposed slopes. Two cave entrances are located to the NW of the unit, Big Salt Cave (a known hibernaculum for Federally Endangered Indiana Bats) and Sky Light Cave, which restricts allowable wind direction during prescribed burn operations.

The first entry burn occurred on 3/26/08 and generally resulting in a great overall burn. Ignition was thoughtfully applied with regard to intensity and topographic positions, thereby achieving objectives related to reduction of fine fuels (primarily leaf litter), mortality of poles, and retention of overstory. Additionally, no significant smoke impacts were observed around the Big Salt cave entrance during the burn.

The current second entry was carried out on 4/3/12 under early growing-season conditions, with oaks just beginning to leaf out but still only low to moderate shading from the emerging canopy. Ignition was focused along the ridgeline and upper slopes of the unit, and fire behavior was generally low intensity, backing and flanking down from the upper slopes. Ignitions were halted by 1415 due to rain and thunder, but firing was completed across most of the target forest area prior to the storm. Day-of observations and post burn reconnaissance indicated that the overall severity was low and objectives appear to have been met for the target area, with light overstory impacts, significant reduction of leaf litter, and significant top-killing of fire intolerant tree seedlings and poles. Also, no smoke impacts were observed at the entrance to either Big Salt or Sky Light cave.

Two long-term monitoring plots are located in the Lewis Hollow A burn unit, QUCO 08 off the northwest end of the large southeast knob and QUCO 09 off the south side of the same knob. First entry immediate post burn data indicated low-severity effects on substrate (litter, duff, woody fuels, etc.) and very low severity on vegetation, while second entry post burn data showed very light severity on both substrate and vegetation (**Table 1**).

**Table 1.** Post-Burn average severity ratings following 1<sup>st</sup> and 2<sup>nd</sup> entry burns  
(n=8 transects)

| Monitoring Status | Substrate Severity Rating      | Vegetation Severity Rating     |
|-------------------|--------------------------------|--------------------------------|
| 01Post            | 3.1 (Light Burn)               | 3.7 (Light to Very Light Burn) |
| 02Post            | 3.9 (Scorch / Very Light Burn) | 4.1 (Scorch / Very Light Burn) |

Measurements of fuel loading taken immediately following this second-entry burn (02 Post) compared to fuel loading measured in 2009 (2 growing seasons after the first burn - 01yr02)

measurements indicated a significant reduction in litter depth and very light reduction of fine woody fuels (**Table 2**). This comparison also indicated a significant increase in 1000-hr fuels and no real change in duff depth. However, it should be noted that the 01yr02 data were taken 3 years prior to the 02Post and do not account for increases in woody debris due to windfall or further recovery of litter and duff during the interim.

**Table 2.** Current status (02Post) of fuels at Lewis Hollow compared to status in 2009 (01yr02) (n=8 transects).

| Monitoring Status | Total Fine Woody Fuel Load (tons/ac) | Total 1000hr (tons/ac) | Duff Depth (in) | Litter Depth (in) |
|-------------------|--------------------------------------|------------------------|-----------------|-------------------|
| 01yr02            | 2.26                                 | 1.52                   | 0.5             | 0.8               |
| 02Post            | 2.01                                 | 2.27                   | 0.6             | 0.3               |
| % Change          | -10.9%                               | +49.7%                 | No change       | -65.3%            |

A comparison of the change in average pole and overstory tree density by monitoring status for combined plots is displayed in **Table 3**. These data show significant reduction of poles 1 growing season after the first burn, and additional small decreases in subsequent sampling. There was no impact to overstory trees detected in the 1<sup>st</sup> growing season following the first burn, but note the delayed mortality 2 growing seasons after the first burn (01yr2). No change to the overstory was detected following the 2012 burn (02yr1).

**Table 3.** Average percent change in pole and overstory tree density by monitoring status for Lewis Hollow plots (n=2 plots).

| Pre-Burn vs. 1st Growing Season After 1st Burn |        |       | 1st vs. 2nd Growing Season After 1st Burn |        |        | 2nd Growing Season After 1st Burn vs. 1st Growing Season After 2nd Burn |        |       |
|------------------------------------------------|--------|-------|-------------------------------------------|--------|--------|-------------------------------------------------------------------------|--------|-------|
|                                                | Poles  | Trees |                                           | Poles  | Trees  |                                                                         | Poles  | Trees |
| 00pre                                          | 14     | 59    | 01yr01                                    | 5      | 59     | 01yr02                                                                  | 4      | 53    |
| 01yr01                                         | 5      | 59    | 01yr02                                    | 4      | 53     | 02yr01                                                                  | 2      | 53    |
| % Change                                       | -64.3% | 0.0%  | % Change                                  | -20.0% | -10.2% | % Change                                                                | -50.0% | 0.0%  |

Overall, post burn reconnaissance and data collection appear to agree that objectives were met and the second entry was fully successful despite lighter severity and reduction of area burned due to precipitation. Firing operations for Lewis Hollow serve as a good model for applying fire to upland dry/mesic oak forest, especially when considering larger landscape scale burns.

### **Wilderness Road Campground A (50 acres):**

Wilderness Road Campground A prescribed burn unit is located along highway 58 in the rolling foothills below Cumberland Mountain. It is directly adjacent to the Lewis Hollow A burn unit, and it surrounds the west and south portions of the Wilderness Road Campground area of Cumberland Gap National Historic Park in Lee County, VA.

This unit has a heavy disturbance history, hence most of the forest is early- successional mixed hardwoods or Virginia pine (*Pinus virginiana*)-eastern redcedar (*Juniperus virginiana*).

Generally, leaf litter is compact and shaded, there are several scattered areas of heavy fuel loading from beetle-killed pine, and exotic plants are commonly interspersed throughout the unit. The exception is the northeast most knob, located just north of the CUGA Wildland Fire Module office which has a small area of second growth dry/mesic oak forest.

This unit has been burned 2 previous times, once on 3/21/05 and again on 11/28/06. The current 3<sup>rd</sup> entry was carried out on 2/28/12. The ignition pattern generally involved bringing fire down from the high points. Fire backed and flanked in a continuous manner with low intensity through the oak forest on the northeast knob and on most of the south and west exposures, but was more spotty on north and east aspects. Fire intensity was highest along the southern edge of the unit due to strip headfire ignition and wind influences off of highway 58. Day-of observations indicated that objectives were met for the target forest area which encompassed the forest from the Module office north to the northeast knob. This area exhibited low-severity fire effects with little to no impact to the oak overstory, good consumption of leaf litter, and some top-killing of tree seedlings and poles.

There are 2 FMH monitoring plots in the Campground unit: a Virginia pine plot (PIVI 01), located a southwest of the Module office, that has never burned due to shading, sparse compact fuels, higher fuel moisture, and vegetation type, and a scarlet oak plot (QUCO 03) located on the northeast most knob in the only area of reasonable quality second growth dry/mesic oak forest.

Fuel loading was measured in the QUCO 3 plot immediately prior to this 3<sup>rd</sup> entry burn. Post-burn measurements of fuels loading were taken a month and a half after the burn. Comparison of “pre-burn” (02yr06) and post-burn fuels (03Post) indicate most of the litter was removed while 1000hr fuels showed little to no change (**Table 4**). The increase in fine woody fuels is possibly due to the delay in post burn data collection allowing more time for small dead twigs and branch (1hr and 10hr fuels) to fall following the burn. There was no real change in duff depth.

**Table 4.** Campground plot QUCO3 “preburn” (02yr06) and immediate post-burn (03Post) average fuel load/depth comparison (n=4 transects).

| Monitoring Status | Fine Woody Fuels (1hr, 10hr, 100hr) (tons/ac) | 1000hr Fuels (tons/ac) | Duff Depth (in) | Litter Depth (in) |
|-------------------|-----------------------------------------------|------------------------|-----------------|-------------------|
| 02yr06            | 1.22                                          | 5.31                   | 0.8             | 1.7               |
| 03Post            | 3.50                                          | 5.26                   | 0.9             | 0.1               |
| % Change          | +187.3%                                       | -1.0%                  | +20.1%          | -93.3%            |

Post burn severity transect data indicate the effects on substrate (litter, duff, woody fuels, etc.) were low-severity and effects on vegetation were very low-severity. Additionally, data from the first growing season following the 3<sup>rd</sup> entry indicated only slight reduction in pole density and no change in overstory cover.

Given post burn data and general reconnaissance of the unit, objectives for the target forest area were met and overall fire intensity was maintained within desired parameters. A large portion of the unit, however, is low-quality successional forest with moderate to heavy exotic plant

encroachment, and does not fall under the target forest community. Prior to future treatments of this unit, it might be beneficial to develop some clear written aesthetic objectives for the non-target areas of the unit since much of this area is adjacent to public use camping sites.

### **Harlan Road A (234 acres):**

The Harlan A unit was burned for a second time on 3/27/2012 by the Cumberland Gap Wildland Fire Module. The first burn occurred at approximately the same time in 2008. The vegetation community for the burn unit is predominantly Chestnut oak forest (Xeric type) or Appalachian Montane-Oak Hickory Forest. Major tree species are Scarlet oak and Chestnut oak with occasional stands of beetle-killed-pine. Fuel is mostly oak litter. Data presented in this report was collected from long-term fire effects plots, FEMO report from the day of the burn, and general observations made while collecting plot data.

### **Fire Observations:**

The observed weather for the day had a high temperature of 75 at 1700 and a low rH of 20% at 1600 with winds 2-5 out of the north and west. The predicted temperatures and rH were very similar. Firing started on the south end of the unit and worked along the trail to the north using a 1, 2, 3 firing sequence. Firing pattern was fairly consistent, allowing for the 2 and 3 igniters to use dot technique and the 1 igniter to use a strip technique. As a whole, the majority of the ignition and behavior was backing fire with desirable low intensity. As night fell and rH went up, the fire continued to burn, though it became a low, creeping fire as it approached the lower slopes. Available fuels were mostly scarlet oak and chestnut oak leaf litter. The 1 hr and 10 hr fuels were partially consumed, along with occasional 100 hour fuels on high-energy slopes. The heavy fuels (1000-hr) remained mostly intact, with consumption ranging from light char to occasionally smoldering to ash.

This burn was well executed and general fire behavior was outstanding. Flame lengths remained less than 4ft, with rates-of-spread under 3 chains per hour and flame zone depths minimal (**Figure 1**). The majority of the landscape burned in low-intensity backing fires, with occasional flanking or head fires. The one unintended slop-over was where it would be expected on the landscape, on an under-slung portion of trail. This amounted to an additional 3 acres burned. Control of the slop-over delayed ignition and thus the north end of the unit containing shaded fuels received no fire on Day 1 (it was burned out on Day 2). The fire was allowed to back into the night without ignition at the bottom of the slope, which provided for excellent fire effects on fuels and small trees, but minimal impacts to the oak overstory (as called for by the objectives). This was a very interesting and effective burn, with the line of backing fire stretched almost the entire length of the unit and burning in varying degrees of coverage throughout the night. Rates of spread were reduced to ¼ chain an hour and fire crept as it backed throughout the night.



**Figure 1.** Typical backing fire in the middle of the Harlan A unit.

The following day weather became windy and dry early in the morning and fire behavior increased as light hit south and west slopes. Operations had 1 spot on the lower slopes of the unit but extinguished it immediately. Any remaining areas of unburned fuel were fired and lines secured awaiting the oncoming rain. The unburned pockets of fuel were relatively small in size and fire behavior was minimal due to extensive backing fires from the previous day's operations.

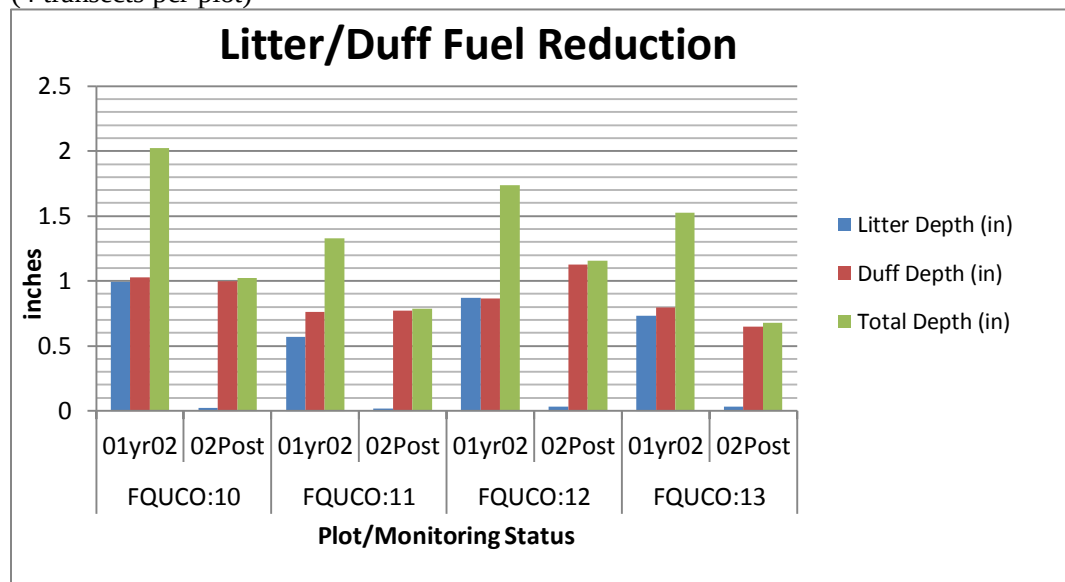
### Fire Effects

Fuel reduction was excellent for this second-entry burn, and Overstory mortality on oaks was minimal. During the growing-season monitoring survey, it appeared that fire-intolerant species (e.g. red maple) had sustained noticeable fire damage that should eventually lead to their decline with successive burns. Upon inspection of the unit during the growing season, fire-intolerant understory stems were severely top-killed by fire. In particular, the saplings of red maple, sourwood and blackgum have been greatly reduced, leading to very open understory conditions and increasing abundance of herbaceous species. The 4 long-term fire effects plots appeared to be fairly representative of the burn overall; the plots all burned completely and, on average, with low severity.

The following bullets summarize the monitoring findings for Harlan A:

- Reduction of litter depth averaged 97% (**Figure 2**)
- In general, duff depth saw was unchanged, and the reduction of total depth was nearly 50%, largely reflecting changes in litter
- Average substrate severity for the 4 plots was "Light burn"
- Average vegetation severity for the 4 plots was "Scorch" (very light)
- Minimal exotic plants were observed in the unit following the burn; these had generally been detected before the first burn of Harlan
- Limited overstory mortality caused by fire over the general unit.

**Figure 2.** Change in fuel bed depths between 2009 (01yr02) and 2012 (02 Post)  
(4 transects per plot)



### Discussion and Recommendations

After having 2 successful prescribed burns with low intensity and low severity, this is an excellent unit that stands out as an exemplary achievement of fire re-introduction into the oak system. As shown in the graph above, fuel depths have successfully decreased as a result of this second burn. The continued application of fire to the oak system is currently keeping the fuel loading at manageable level as to mitigate resource damage in the event of unexpected human ignition.

With regard to Oak mortality, since the installation of the monitoring plots, we have observed occasional mature oak death that does not appear to be associated with fire effects. This phenomenon has also been noticed throughout other parts of Tennessee and Kentucky. The thought is that these larger scarlet and white oaks may be succumbing to oak decline or hurt by drought-like conditions experienced in 2007 and 2010. Nonetheless, this is very small phenomenon and observed only with small numbers of trees at Cumberland Gap. Finally, as with many sites at the Gap, invasive exotic species are present and may increase with the fire disturbance, especially where combined with other disturbances such as southern pine beetle. Continual monitoring and focused control should be a high priority.

## Long Term Monitoring Results and Discussion

With the second entry of prescribed fire into the Harlan A and Lewis Hollow burn units, there were sufficient plots numbers to update the data analyses for total fuels, pole-sized trees, and overstory trees (**Table 5**). For the first time, we were able to look at the effects of two burns on these core objectives at Cumberland Gap. The results suggest that after the second burn there was no additional reduction of total fuels when compared to reduction following the first burn. Successive reduction of total fuels in most plots, however, is masked by large increases in 1000-hour fuels in 2 plots, QUCO 1 and QUCO 2 (**Figure 3**). While increases in 1000-hour fuels (logs > 3 inches diameter) are not uncommon early in the prescribed fire restoration cycle, these dramatic increases are the result of pre-fire beetle-kill of pines, heavy overstory mortality during the initial prescribed burn of Dark Ridge A/B, and subsequent falling of snags and large limbs (**Figure 4**). The negative impacts of these high-mortality events on achievement of program goals has been discussed in past reports, but this is a clear example of the impact to achievement of fuel reduction objectives. Fortunately, the program has made appropriate adjustments, and the high-intensity burning that produced these effects has been greatly lessened at CUGA (**Figure 4**).

**Table 5.** Results of long-term fire effects monitoring at Cumberland Gap NHP.

| <b>Vegetation Type</b>                         | <b>Management Objective<br/>Restoration Phase-<br/>(After 4 burns)</b> | <b>Monitoring Results<br/>(80% confidence intervals)</b>                                                                                            | <b>Objective Achieved?</b>              | <b>Year Last Analysis Completed</b> |
|------------------------------------------------|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-------------------------------------|
| Dry Oak Forest (FQUCO1)<br><br><b>16 plots</b> | >50% Reduction in total fuel loading                                   | <b>Total Fuel Reduction:</b><br>After 1 burn = 29% ( $\pm 3$ )<br>(n = <u>16</u> plots)<br>After 2 burns = 26% ( $\pm 2$ )<br>(n = <u>11</u> plots) | <b>Not yet, but on course</b>           | <b>2013</b>                         |
|                                                | >70% Reduction in pole-sized tree density ( $\leq 15$ cm dbh)          | <b>Pole Reduction:</b><br>After 1 burn = 39% ( $\pm 5$ )<br>(n = <u>16</u> plots)<br>After 2 Burns = 67% ( $\pm 3$ )<br>(n = <u>11</u> plots)       | <b>Not yet, but close</b>               | <b>2013</b>                         |
|                                                | 15-30% Reduction in overstory tree density (>15cm dbh)                 | <b>Overstory Tree Reduction:</b><br>After 1 burn = 5% (+ 5)<br>(n = <u>16</u> plots)<br>After 2 Burns = 8% ( $\pm 1$ )<br>(n = <u>11</u> plots)     | <b>Not yet, but on course</b>           | <b>2013</b>                         |
|                                                | >200 tall (>1m) Oak seedlings /acre                                    | Preburn mean: 101/acre ( $\pm 12$ )<br>After 1 burn: 91/acre ( $\pm 6$ )<br>(n=16 plots)                                                            | <b>Not yet.</b>                         | <b>2011</b>                         |
|                                                | >30% Cover by native herbs                                             | Mean preburn cover = 2% ( $\pm 1\%$ )<br>Mean after 1 burn = 4% ( $\pm 2\%$ )<br>(n=14 plots)                                                       | <b>No, but more burns are needed.</b>   | <b>2011</b>                         |
|                                                | < 20 Invasive exotic plants/acre                                       | Preburn avg: 0/acre<br>Post burn mean: 20/acre ( $\pm 14$ )<br>(n=16 plots)                                                                         | <b>Unclear due to high variability.</b> | <b>2011</b>                         |

**Note:** An underlined sample size number indicates minimum plots exist for 80% Confidence Level.

**Figure 3.** Total fuel loading (“Total”) and 1000-hour fuel loading (“1000hr”) by plot for: Preburn (Pre), After 1 burn (01), and After 2 burns (02). Note the large increases in 02 1000hr fuels in plots QUCO 1 & 2.

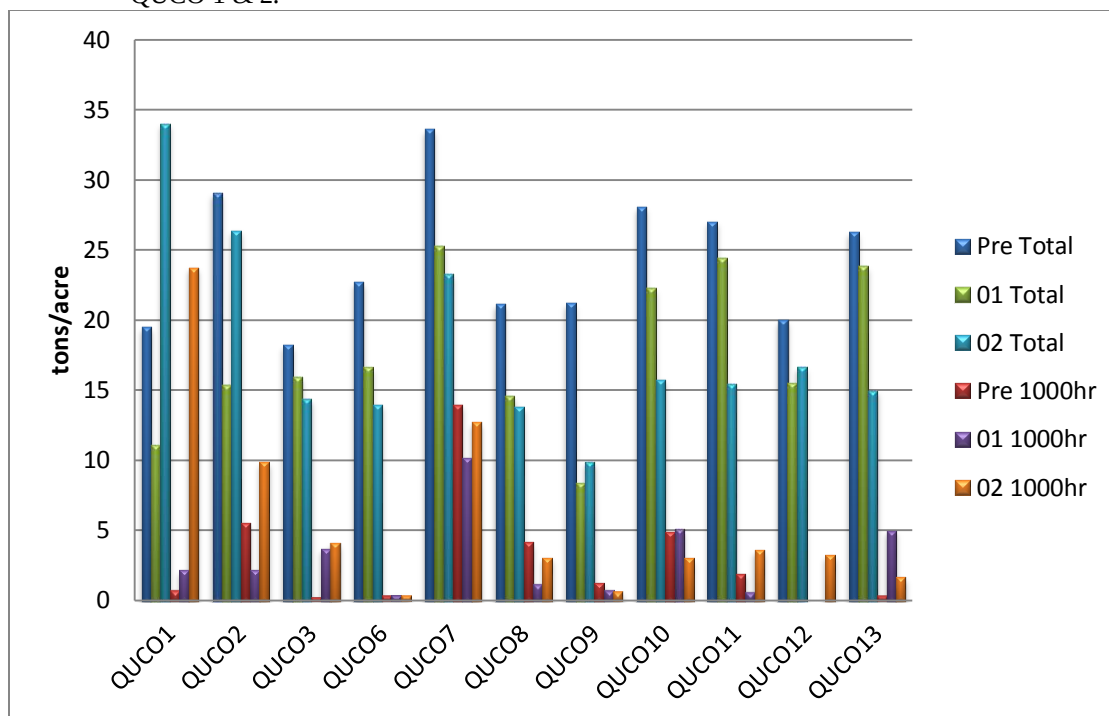
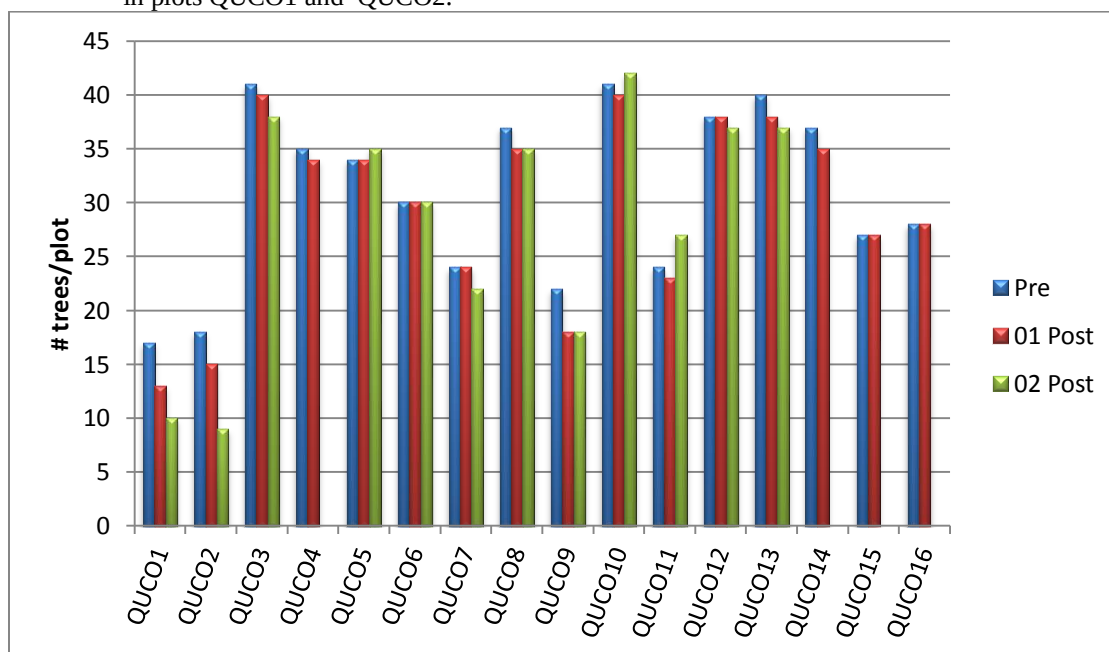
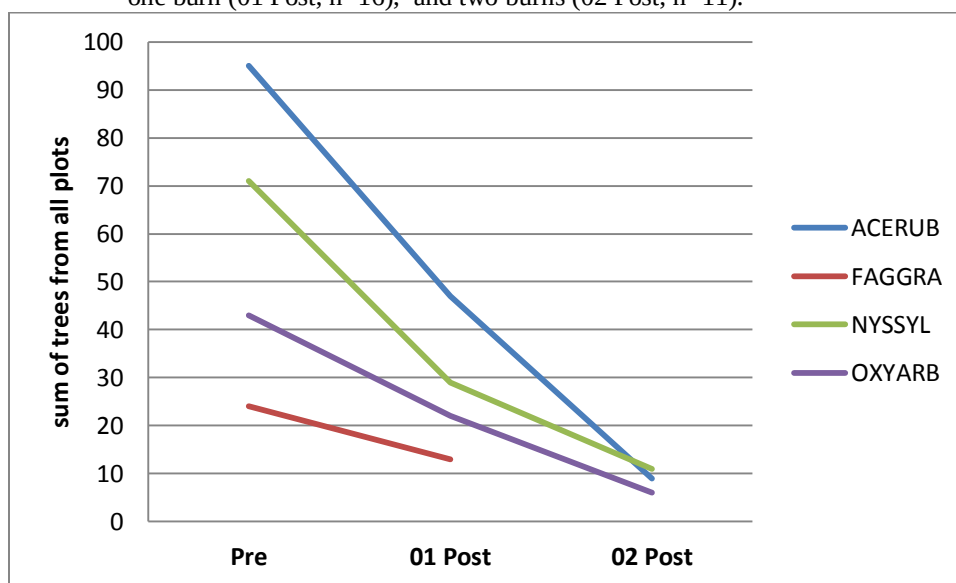


**Figure 4.** Number of overstory trees per plot for: Preburn (Pre), After 1 burn (01 Post), and After 2 burns (02 Post). Note the lower numbers of trees preburn and the larger reductions in plots QUCO1 and QUCO2.



Results for pole sized trees (<15cm dbh) following two burns are fairly typical for Appalachian oak forests, and are well within the desired range (**Table 5**). In fact, the average reduction for the eleven plots that have been burned twice are very near to meeting our objectives. The greatest reductions in this size class were, by far, among the fire-intolerant species that currently dominate the understory of oak forests throughout CUGA (**Figure 5**). Given the prolific resprouting capability of each of these species, it will be vital to continue burning frequently (3-5 years) to control them and allow oak saplings to accumulate in the forest understory.

**Figure 5.** Reduction of the four most abundant midstory tree species after: one burn (01 Post, n=16), and two burns (02 Post, n=11).



New analyses were not completed for oak seedlings, herbaceous cover, and exotics (**Table 5**). Analysis of 2-burn data was not done for seedlings because over half of the 2-burn plots were in the first growing season following that second burn. It normally takes a couple of growing seasons post-fire for the seedlings to reach the height we are sampling for (>1m tall). A new analysis of oak seedlings should be possible in next year's report. Due to safety concerns with intensive sampling of the herb layer in several plots, there are not enough plots with 2-burn cover data to warrant an analysis. Again, these results will be updated as additional data become available. Finally, no update is available for exotic plants. We have developed a custom sampling method for exotics, but still need to create the appropriate tables in the database so we can enter, store, and query the data. This should be accomplished by next year's report. Anecdotally, invasive exotics do not appear to be increasing except in sites that have experienced high overstory mortality/gap creation. These are Dark Ridge A/B, Hoot Owl Hollow, and small areas along the "College Road" in Dark Ridge C and Sugar Run B.

# Great Smoky Mountains National Park (GRSM): 2012 Fire Effects Monitoring Annual Report

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## Activity Summary

As always, the prescribed burning, fire effects, and fire ecology of our home park was a major focus for the monitoring crew in 2012. The team continued to be heavily involved in nearly all phases of the prescribed fire program, from planning and unit prep to implementation and monitoring. As a result, the GRSM Fire program was poised to complete outstanding burns at both Lynn Hollow (spring) and Wear Cove Gap (fall), but missed both opportunities due, in part, to being narrowly out of prescription for atmospheric dispersion. Effective completion of these projects will be a goal in the coming year.

Long-term fire-effects monitoring (year 10 post-burn) was completed for the Tabcat A and B units in the southwest corner of the park. Tabcat A was one of the first prescribed burns ever done at GRSM, and has been an important source of data that has been used to shape and improve the park's prescribed fire program. In this spirit, a review of the year-10 monitoring is provided below in this report. The crew was unable to complete year-5 post-burn plot reads at Beard Cane and Wedge Ridge due to extensive tornado damage in that part of the park. An attempt was made to relocate one of the Wedge Ridge plots, but was unsuccessful. The inability to access and read the Beard Cane/Wedge Ridge plots is a good lead-in to a brief introduction of the team's efforts to develop an alternative monitoring strategy for short and long-term fire effects. As discussed in last year's Annual Report, several factors including crew safety and evolving program scope have pointed to a need for additional monitoring tools to supplement our traditional protocols. A major focus of our work at GRSM during 2012 was the development and testing of field methods that could achieve the following goals:

- 1. Allow the crew greater control of exposure time to hazards and hazard mitigation***
- 2. Allow the crew greater control of sampling location while limiting bias***
- 3. Provide ground-truthing compatibility with remote sensing data***
- 4. Allow for greater sample size.***

A description of the alternative monitoring protocol and examples of some of the data products are included below in this report. In addition to adding this tool to our long-term fire effects monitoring at GRSM, we are cooperating with researchers at Western Carolina University to use a similar approach to answer fire-effects questions with more rigorous science. We have been successful in competing for research funding from NPS National Fuels Research Reserve, and have also submitted a proposal to the Joint Fire Science Program for a larger grant. The full proposal to the NPS Fuels Reserve is included in **Appendix A** of the full report. It is hoped that these complementary efforts will help to more fully develop and validate our new monitoring concepts.

## Program Goals and Objectives

One of the successes of our fire-effects monitoring program has been its contribution to the development of short and long-term objectives for the prescribed fire program. Monitoring data have been continually used to evaluate and improve objectives, and this is indicative of major advances in understanding Appalachian fire ecology over the past 15 years.

In past years' reports, we've used this space to communicate evolving goals and objectives as new data and knowledge have become available. This year there are no significant changes in goals and objectives for GRSM, so in the interest of reducing the length of this report, the reader is referred to last year's report which can be found on the SER Fire Sharepoint (or on the V: drive).

## Review of 2012 Projects

### **Cades Cove (547 acres):**

All scheduled burns in Cades Cove were completed during November of 2012 (**Table 1**). Highlights included the re-burn of Old Field. The last burn of this area was spring 2009, and a tremendous number of sweet-gum saplings had grown up in the interim. Many of these saplings had also achieved substantial diameter (>3cm), raising concerns that prescribed burning alone would be effective at controlling them. To assist to the park in achieving its goal for maintaining open fields in Cades Cove, volunteers manually cut hundreds of these encroaching woody stems from the west end of Old Field during the summer of 2012. These efforts greatly enhanced the ability to achieve a complete burn of the unit.

**Table 1.** Fall 2012 Cades Cove Burns.

| Field Name                            | Size (acres) |
|---------------------------------------|--------------|
| Old Field (traditional lower portion) | 60           |
| Maple Branch                          | 174          |
| Sparks Lane                           | 113          |
| Elijah Oliver                         | 10           |
| Cemetery Marsh (+ old hay lease)      | 181          |
| Martha's Branch                       | 9            |

The Fire Effects Monitor assigned to the burn estimated that over 95% of the unit burned with good intensity and consumption of fine fuels over most of that area (**Figure 1**). It also appears that top-kill of sweet-gum was very good in most areas. This species, of course, has a strong ability to resprout following top kill, so it will be imperative to return to the Old Field with a 1-2 year rotation for the next several burns. Concerns about fire impacting the mature forest of the Abrams Creek riparian corridor were mitigated by firing directly on the forest edge. Fire effects monitoring revealed that though there was a significant amount of fire spread in the riparian forest, it was low intensity backing fire, which poses little risk to mature trees.

**Figure 1.** A complete burn with excellent intensity; this should result in top-kill of many sweet-gum stems in Old Field.



Another interesting highlight of 2012 Cades Cove burning is the inclusion of the former west-end hay lease in the Cemetery Marsh burn. This field has been managed for tall-fescue hay production for some time (at least 13 years), and prior to the burn, could be characterized as a very low-diversity tall-fescue/broom-sedge hay field (**Figure 2**). The long-term resource management goal for this area will be to use fire and native plantings to restore the field to a more structurally and compositionally accurate remnant of historic Cades Cove native grassland. The area will be monitored during 2013 to assess the effects of this first burn.

**Figure 2.** First-entry burn of the former hay lease (west-end).



### **Long-Term Monitoring of the Tabcat Prescribed Burn Site:**

The Tabcat burn of August 4, 1997 was the first prescribed burn in GRSM park history. The area was slightly enlarged and re-burned in early April, 2003. The original Tabcat burn has become a watershed event that has been a tremendous source of learning about burning in the Southern Appalachians. Results of the burn have been featured in countless oral presentations and even a publication. During summer 2012, the Tabcat plots were re-sampled as part of a 10-year post-burn read. The following discussion provides a look at some of the longer-term results from the original Tabcat burn and summarizes the information gained there.

The 1997 Tabcat burn was centered around known former-Red-cockaded woodpecker cavity trees, with the goals of restoring the structure and function of an example of the mixed pine-oak forest that covers much of the park's western end. Coming out of an era when all wildfires had been immediately suppressed, this area had not experienced any significant fires in 60 years. At that time, few land managers in the Southern Appalachians had used fire to manage for pine and oak forest, and there was very little knowledge of how to actually apply fire to meet those goals. The following words, included with the Goals and Objectives to the 1997 Rx Burn Plan, speak volumes:

*There is virtually no knowledge of the fire effects that will be experienced in these biotic communities when burned during the growing season. As a result, a wide range of effects will be considered acceptable.*

Fortunately for us, the GRSM staff had installed four permanent plots in the unit prior to burning...

Post-burn monitoring of the '97 fire revealed an unexpectedly severe burn, with relatively high reductions in total fuels that featured several days of smoldering through several inches of duff (**Table 2**).

**Table 2.** Plot-level post-fire summaries for the 1997 Tabcat prescribed burn. Data were taken between 1997 and 2000. Pine-oak forest type.

|       | Total Fuel<br>Reduction | Duff<br>Reduction | Overstory<br>Stems | Pole-<br>Tree<br>Stems | Increase<br># of spp. | Change in<br>Mt. Laurel<br>cover | Paulownia<br>Seedlings? | # Pine/ha<br>Seedlings<br>2 yr Post |
|-------|-------------------------|-------------------|--------------------|------------------------|-----------------------|----------------------------------|-------------------------|-------------------------------------|
| PIBO1 | -58%                    | -64%              | -51%               | -75%                   | + 15%                 | -80.6                            | Yes                     | 1400                                |
| PIBO2 | -78%                    | -86%              | -65%               | -100%                  | +19%                  | -91.7                            | Yes                     | 8800                                |
| PIBO3 | -65%                    | -69%              | -14%               | -64%                   | +100%                 | -87.5                            | No                      | 0                                   |
| PIBO4 | -67%                    | -81%              | -55%               | -100%                  | +50%                  | 0                                | Yes                     | 7400                                |

Within 2 years of the burn, nearly half of overstory trees in the plots had died, and there had been a fundamental change in the structure and composition of the pine-oak forest (**Figure 3**).

Despite achieving large increases in pine regeneration and species richness, the loss of so many overstory trees and the appearance of hundreds of *Paulownia tomentosa* (princess tree) seedlings are highly negative outcomes that have shaped burning practices at GRSM and elsewhere ever since. Most importantly, objectives for first-entry burns today emphasize the use of light,

dormant season burns to ease fire back into the system and avoid burning large quantities of duff that can lead to unacceptable impacts to soils and overstory trees.

The second burn of the area in 2003 was also a fairly hot burn that, predictably, resulted in the loss of more overstory trees (**Table 3**). Due to unsafe working conditions posed by numerous snags, data collection following the second burn became spotty. In 2012, when the 10-year reads for Tabcat came up, the crew decided to revisit the site, conduct a safety assessment, and collect whatever data could be collected safely.

**Figure 3.** PIBO1, view of P2– 2 years post fire. Slide scan.



**Figure 4.** PIBO1, view of P2– 10 years after second burn.



**Table 3.** Number of live overstory trees in Tabcat plots by burn status.

|       | Preburn<br>1997 | After 1 Burn<br>1999 | After 2 Burns<br>2007 | 10 years after<br>2 <sup>nd</sup> Burn<br>2012 |
|-------|-----------------|----------------------|-----------------------|------------------------------------------------|
| PIBO1 | 45              | 22                   | 11                    | 10                                             |
| PIBO2 | 43              | 15                   | Not collected         | 3                                              |
| PIBO3 | 29              | 25                   | 12                    | 9                                              |
| PIBO4 | 44              | 20                   | 3                     | 3                                              |

Though two of the plots were only deemed safe for minimal data collection, data were collected for overstory trees in all plots, and qualitative assessment forms were filled out for each plot. Photos were taken in all but one plot. No herb-layer data were collected, though the qualitative assessments provide some information about the dominant species in the understory.

Ten years after the second burn of the Tabcat burn unit, the overall picture is one of a series of large canopy gaps with a dense regeneration layer about 2-4m in height (**Figures 5 and 6**). The density of overstory trees (approx. 400/ha prior to burning) now averages around 55/ha. For reference, the long-term objective for overstory density in managed pine-oak forests is around 200-300 stems/ha. The few surviving overstory trees are (in descending abundance): Pitch pine, Chestnut oak, Shortleaf Pine, Virginia Pine, and White Pine.

**Fig. 5.** Tabcat – 10 years after 2<sup>nd</sup> burn



**Fig. 6.** Tabcat – 10 years after 2<sup>nd</sup> burn



Having been released by the removal of the canopy, pole-sized stems are at least 140% more abundant compared to pre-burn values, and the number of seedlings has nearly doubled. In contrast with pre-burn composition, however, the pole and seedling classes are now dominated by yellow pines and various oaks. Other species in the regeneration thicket include Black gum, Dogwood, and Black Locust. Anecdotally, the herb layer remains much more diverse and productive than that in unburned pine-oak forests in the park, and much more so than the same stand prior to burning. However, over the past ten years, the herb layer has become progressively diminished as woody trees and shrubs have reasserted dominance on the site.

To summarize, Tabcat was the first prescribed burn conducted at GRSM, and few people knew what to expect. Conventional wisdom at the time was that growing-season burns favored yellow pines, which was the objective of this burn. So...the burn was conducted under moderate drought conditions, in the growing season, and with a mixture of fire intensities that included strip head-fires. As a result, severity to trees (char and scorch) and severity to substrate (deep duff consumption) was very high, resulting in the death of over half of the canopy trees. Delayed mortality and tree damage inflicted by the first burn were compounded by subsequent burning, and today there are very few over-story trees remaining on the ridges and south-facing slopes on the burn unit. On a positive note, the first burn resulted in an impressive amount of yellow pine regeneration and dramatic increases in herbaceous cover and diversity, which were goals of the burn.

What did we learn from Tabcat? While we learned that restoration of pine regeneration could be accomplished with a single burn, we began to see that such restoration might be better achieved through a series of lower-severity burns. Since the establishment of the park and the onset of fire exclusion policies, fuels have accumulated for decades throughout most of the park's most fire-prone areas. As we have seen from several notable growing-season wildfires and the Tabcat burn, when large portions of this fuel are consumed during a single event there are effects that may be outside the historical range of variability. That is an open question.

Whether these events have historical analogs or not, the negative consequences are considerable: excessive mortality of high quality seed trees, creation of immense quantities of woody fuels on extremely dry sites, soil erosion, and invasion by aggressive exotic plants. The Tabcat burn brought all of these tradeoffs into clear view, and as a result we understand that managing fuels and vegetation with fire is about finding the right balance between our desire to achieve structural and compositional goals today and maintaining long-term health and sustainability.

### **Alternative Monitoring (Landscape Fire Effects Mapping):**

#### **Background**

Great Smoky Mountains National Park has used prescribed fire and naturally-occurring wildfires to manage fuels and vegetation since 1997. As directed by National Park Service policies, these management actions have been monitored by a variety of methods that are designed to assess program effectiveness, detect undesirable trends, and provide data for adaptive management. Ability to achieve these monitoring goals is constrained by high levels of variability in forest type, condition of preburn vegetation, fuel availability during burn events, and ignition type. As a result, while trends in treatment effectiveness and post-burn vegetation dynamics are observable and somewhat predictable, such trends are extremely difficult to quantify with a statistical level of certainty. Further, the sampling design of existing monitoring (FMH) is not suited to providing reliable or timely data for individual burn sites, which is essential in the practice of adaptive management.

There are also important safety concerns associated with existing monitoring that center on unacceptable exposure times in areas of higher severity fire or tornado damage (snags, visibility,

access, extraction time, etc.), which make full days in a single plot untenable in an increasing number of cases (esp. @ GRSM). These concerns result in failure to sample those areas, which, when combined with low plot numbers, places tremendous limits on our ability to adequately sample and describe landscape fire effects. Finally, since no FMH plots are associated with wildfires, there is little to no quantitative data about effects on vegetation structure and dynamics for these events, which can provide information that is vital both to wildfire management and fuels management.

### Methods and Testing

We have used remotely-sensed burn severity mapping (known as dNBR) to illustrate fire effects across burned landscapes for several years (throughout this and past annual reports), but without ground-truthing data these maps remain a bit of an abstraction. During the 2012 field season, a set of ground-truthing protocols and methods were developed and tested at multiple sites within GRSM and BISO. The goals of these efforts were to provide on-the-ground fuels and vegetation data that could be used in conjunction with dNBR data to develop models of landscape fire effects at a variety of scales. Further background on these alternative monitoring efforts, along with a full description of the protocols and intended analyses will become available in the coming year.

### Expected Analysis Products

*Note: The discussion of this monitoring tool in the BISO report contains additional examples of data products.*

Landscape fire effects mapping produces both spatial and tabular data. Maps depicting the dNBR severity classes are extremely useful, and these severity classes can be overlaid on top of vegetation to produce very informative maps (**Figures 7 and 8**). **Figure 7** shows a classified dNBR image of the northern-most portion of the Arbutus Ridge prescribed burn site with three of our test plots. This area has been burned twice and the severity map shows the combined dNBR values for this part of the burn unit. **Figure 8** provides the same view, with the burn severity classes overlaying the GRSM vegetation layer. Here you can see quite nicely that the three plots represent similar vegetation types, but that they have experienced different burn severities according to the dNBR model. The hope for the future is that, once enough ground-truthing data have been collected, a spatial model can be constructed that is capable of providing detailed descriptions of vegetation structure and composition at various post-fire stages.

The most fundamental products are tables that summarize plot structure, diversity and species abundance. These tables are the basis for summarizing the vegetation in each plot, and these summaries can then be sorted by CBI severity score, dNBR score, mapped vegetation type, time since burned, level of pre-fire southern pine beetle damage, KBDI and/or season of burn. Ultimately, these groupings can provide descriptions of post-fire vegetation by severity class. Such an approach has great potential develop and assess landscape scale objectives, and to make predictions about expected vegetation dynamics. A similar approach can be used for fuels.

**Table 4** below illustrates the most basic plot structure summaries. Distinct differences in structure can be observed between plots. For example, extremely low overstory cover (**class D + E**) in Arbutus 002 is coupled with relatively high cover in the understory (**class C**). By contrast, high overstory cover in Arbutus 001 is coupled with low cover in the understory. These

**Figure 7.** Classified burn severity (dNBR) map of the northern part of Arbutus Ridge. Ground-truthing test plots are represented by blue points.

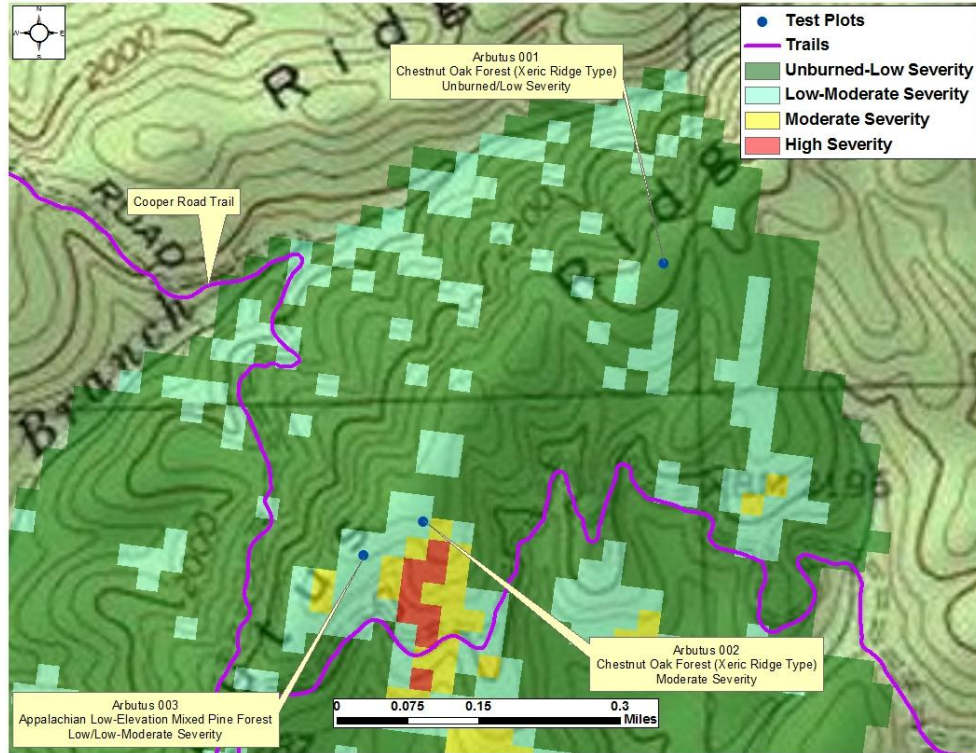
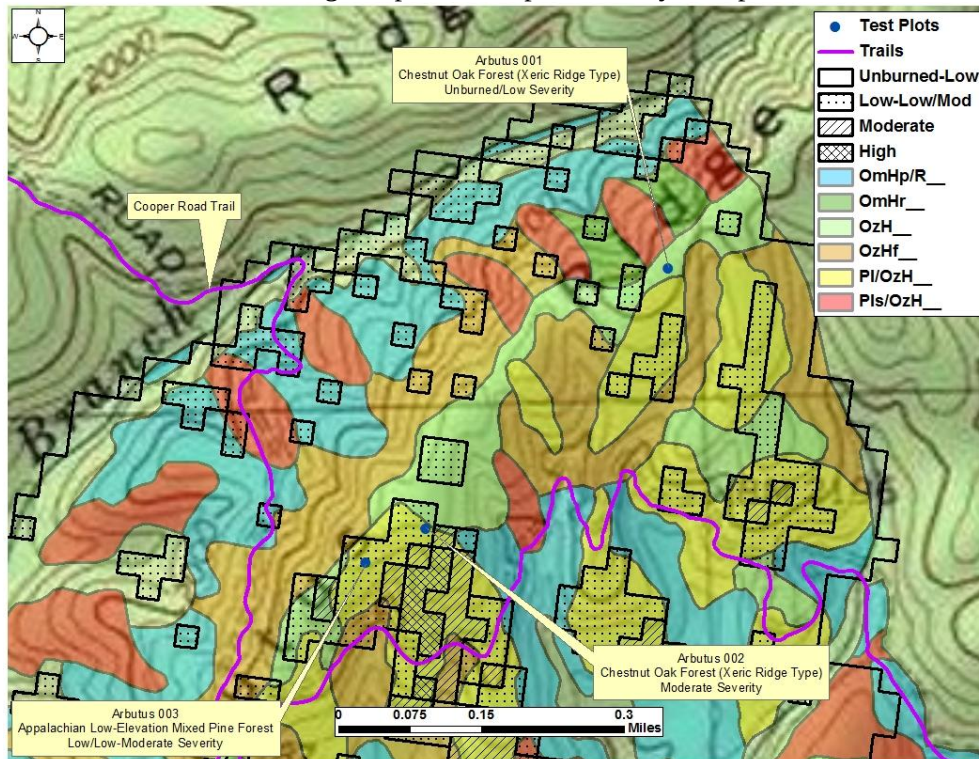


**Figure 8.** Burn severity classes overlaying vegetation at Arbutus Ridge. Ground-truthing test plots are represented by blue points.



structural differences are indicative of differences in severity and will result in dramatically different vegetation dynamics. Such data may provide insights into critical thresholds such as dNBR severity levels that are associated with very low overstory cover and intense growth-release in the understory, or levels that can predict yellow pine regeneration. A demonstration of the types of species composition data available from our methods can be viewed in the BISO report.

**Table 4.** Total cover by stratum for each plot.  
Stratum codes match those used in CBI severity sampling.

| Plot ID    | Total Cover by Stratum |      |      |      | CBI   | dNBR  |
|------------|------------------------|------|------|------|-------|-------|
|            | B                      | C    | D    | E    | Score | Value |
| Arbutus001 | 71                     | 12   | 42.5 | 62.5 | 0.8   | 36    |
| Arbutus002 | 32.5                   | 77.5 | 7.5  | 2.5  | 2.0   | 277   |
| Arbutus003 | 112.8                  | 32.5 | 10   | 40   | 1.3   | 178   |
| LF - 001   | 146.5                  | 43.5 | 95   | 30   |       |       |
| LF - 002   | 123                    | 55   | 45   | 40   | 0.7   | 47    |
| LF - 003   | 119.9                  | 27.5 | 15   | 30   | 1.0   | 102   |
| WCG001     | 92                     | 47.5 | 55   | 15   |       | 81    |
| WCG002     | 67.7                   | 45   | 45   | 37.5 | 0.8   | 2     |
| WCG003     | 124                    | 63.5 | 15   | 47.5 | 1.2   | 169   |

**Strata:** E = Upper canopy, D = Subcanopy, C = Tall shrubs/saplings, B = Herb layer

The tabular data can then be used to explore a large universe of relationships between disturbance severity, composition, structure, topography, and other abiotic indices.

**Figures 9 and 10** demonstrate the relationships between remote-sensing data and ground-truthing data that we need to make fuller interpretations of the remote-sensing data. It is likely that these types of analyses can shed light not only on fire ecology, but on disturbance-related vegetation dynamics in general.

**Figure 9.** Example of a linear relationship between dNBR score and post-disturbance overstory cover.

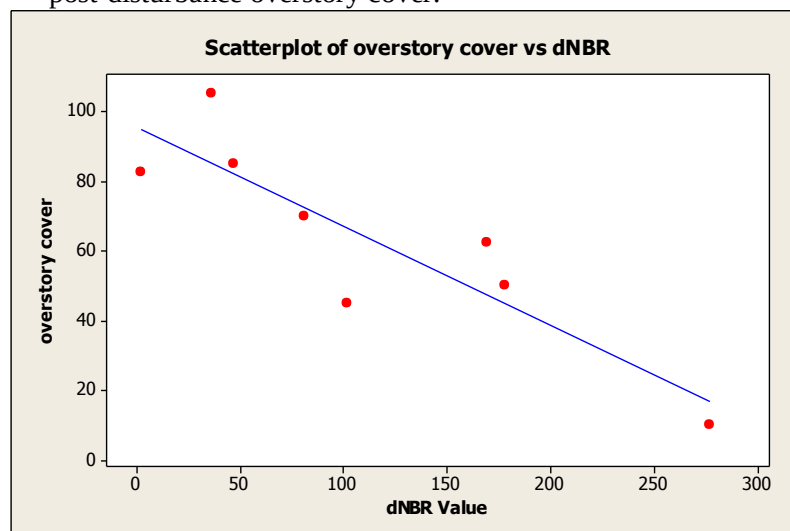
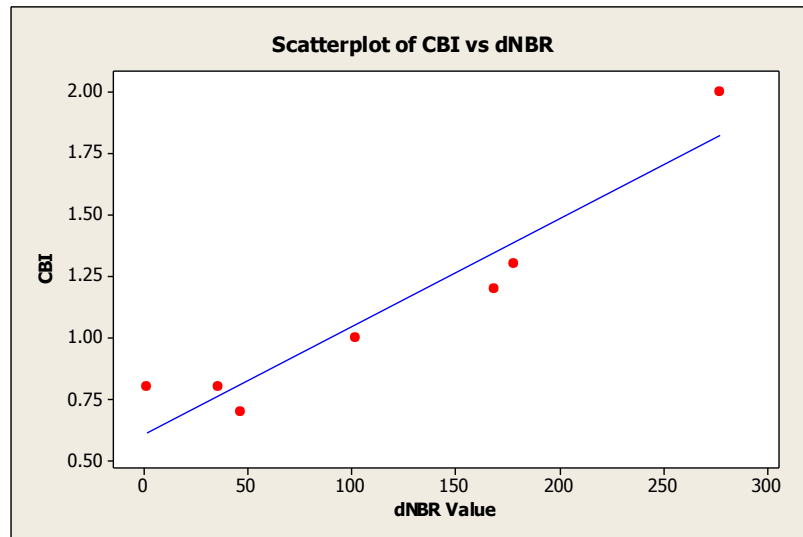


**Figure 10.** The mathematical relationship between remotely-sensed severity (dNBR) and ground-based severity (CBI) is important for establishing meaningful disturbance thresholds.



### **Future of Landscape Fire Effects Mapping**

Taking away time for travel, breaks, and orientation to the new methods, these plots average about an hour to complete, suggesting that in an average week during the field season (4 – 10hr days) we might expect to complete 10-15 plots. By comparison, the same average week in summer may yield 3-5 FMH plots. Furthermore, when coupled with the dNBR imagery, the power of these plots to describe landscape scale fire effects is potentially far greater.

Now that a protocol has been developed and some field testing has occurred, the next step will be to prepare a formal proposal to the Southeast Region and the National Fire Office (Boise). Pending approval of the protocols, the goal for incorporating Landscape Fire Effects Mapping into the long-term monitoring program at GRSM will be to spend roughly equal time on field data collection to support Mapping and collection of high-priority FMH plot data.

We have presented a very brief illustration of some of the products that we expect to develop using the new methods; however, the protocol is designed to produce data that is compatible with a range of additional analyses. These kind of data are especially well suited for multivariate analyses or the development of chronosequences that can help us gain a much better understanding of program effectiveness, fuel treatment lifespan/fuel recovery, and longer term vegetation dynamics for a range of scenarios. As always, we look forward to feedback and active dialogue from all interested parties about this new monitoring tool.

## Long Term Monitoring Results

No fire effects plots have been burned at GRSM since 2010, and consequently there are no updates to the long-term monitoring results for the park. **Table 4** is copied from last year's annual report as a reference for the long-term objectives and the current status of those objective variables. As noted in past annual reports, the prescribed fire program is well on its way to achieving the long term objectives in the yellow pine woodlands, but progress is much slower in the park's dry oak forests. In both the pine and oak forest types, there remains a great disparity in results between burns, with some burns exceeding the objectives quickly and others experiencing only incremental change. The factors leading to these disparities were more fully explored in our recent publication, which was featured in last year's report.

**Table 4.** Objectives and long-term monitoring results for GRSM

| Monitoring Type                                      | Management Objective<br>Restoration Phase-<br>(After 4 burns) | Monitoring Results<br>(80% confidence intervals)                                                                                      | Objective Achieved?                                               | Year Last Analysis Completed |
|------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|------------------------------|
| <b>Yellow Pine Woodland (FPIR11)</b><br><br>27 plots | >50% Reduction in total fuel loading                          | Total fuel reduction:<br>After one burn = 36% ( $\pm 5\%$ ) ( $n=23$ )<br>After two burns = 37% ( $\pm 4\%$ ) ( $n=16$ )              | <b>Not yet, but on course.</b>                                    | <b>2011</b>                  |
|                                                      | >70% Reduction in pole-sized tree density                     | Pole reduction:<br>After one burn = 54% ( $\pm 5$ ) ( $n=25$ )<br>After two burns = 75% ( $\pm 7$ ) ( $n=11$ )                        | <b>Yes</b>                                                        | <b>2009</b>                  |
|                                                      | 25-50% Reduction in overstory tree density                    | Overstory reduction:<br>After one burn = 20% ( $\pm 5\%$ ) ( $n=25$ )<br>After two burns = 41% ( $\pm 9$ ) ( $n=11$ )                 | <b>Yes, but more burns are needed before drawing conclusions.</b> | <b>2009</b>                  |
|                                                      | >200 tall (>1m) Yellow Pine seedlings /ac                     | Preburn density: 0 ( $n=25$ )<br>After 1 burn: 97/ac ( $\pm 49$ ) ( $n=25$ )<br>After 2 burns 49/ac ( $\pm 40$ ) ( $n=11$ )           | <b>No, but more burns are needed.</b>                             | <b>2009</b>                  |
|                                                      | >40% Cover by native herbs/subshrubs                          | Preburn cover: 3% ( $\pm 1\%$ ) ( $n=23$ )<br>After 1 burn: 11% ( $\pm 4\%$ ) ( $n=23$ )<br>After 2 burns 10% ( $\pm 6\%$ ) ( $n=9$ ) | <b>No, but more burns are needed.</b>                             | <b>2009</b>                  |
|                                                      | >50% Reduction in total fuel loading                          | Total fuel reduction:<br>After one burn = 29% ( $\pm 3\%$ ) ( $n=11$ )                                                                | <b>Not yet, but on course.</b>                                    | <b>2011</b>                  |
| <b>Dry Oak Forest (FQUCO1)</b><br><br>15 plots       | >70% Reduction in pole-sized tree density                     | Pole reduction:<br>After one burn = 34% ( $\pm 7\%$ ) ( $n=11$ )                                                                      | <b>Not yet, but on course.</b>                                    | <b>2011</b>                  |
|                                                      | 15-30% Reduction in overstory tree density                    | Overstory reduction:<br>After one burn = 5% ( $\pm 2\%$ ) ( $n=11$ )                                                                  | <b>Not yet, but good gradual movement.</b>                        | <b>2011</b>                  |
|                                                      | >200 tall (>1m) Oak seedlings /ac                             | Preburn density: 20/acre ( $\pm 23$ ) ( $n=10$ )<br>After 1 burn: 4/ac ( $\pm 6$ ) ( $n=10$ )                                         | <b>No, but more burns are needed.</b>                             | <b>2011</b>                  |
|                                                      | >30% Cover by native herbs/subshrubs                          | Preburn cover: 4% ( $\pm 2\%$ ) ( $n=9$ )<br>After 1 burn: 4% ( $\pm 2\%$ ) ( $n=9$ )                                                 | <b>No, but more burns are needed.</b>                             | <b>2011</b>                  |
|                                                      |                                                               |                                                                                                                                       |                                                                   |                              |

# Kings Mountain National Military Park (KIMO): 2012 Fire Effects Monitoring Annual Report

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## Activity Summary

The monitoring crew made four trips to KIMO during 2012. Two trips were made during the spring fire season; one to prep and plan Garner Creek, which was not completed due to weather, and one to conduct the second-entry burn of the Midway and Swale burn units (now combined as North-Central). Subsequent trips were made to conduct immediate post-burn monitoring and long-term monitoring of WTP and North-Central. A detailed account of those burns and the associated monitoring can be found in this report. Other work focused on pre-burn planning for Eastline and long-term monitoring of Piedmont Road.

There was a 50% reduction in travel for growing-season field work in 2012 due to decreases in funding. Given the large reduction in trips during the growing season, the crew did not complete all scheduled long-term monitoring plot visits in 2012. Year-2 reads of numerous plots in the Saddleback and Brushy North burn units were not completed, nor were year-5 reads of the plots in Dellingham. It is likely that year-2 and year-5 reads will become a lower priority with reduced funding.

The fire ecologist made two visits to KIMO during 2012, both trips to help prep, plan, and burn the 2012 burn units. Also of interest to KIMO, the ecologist made significant progress on developing and testing a field method to serve as ground-truthing for the remotely-sensed burn severity images (dNBR) that are routinely featured in our annual reports. The discussion of “Alternative Monitoring (Landscape Fire Effects Mapping)” found in the Big South Fork and Great Smoky Mountains sections of this annual report contains a description of this approach and examples of the spatial and tabular data that can be generated from these methods. We currently have such remote-sensing data for several of the past burns at KIMO, and we have the ability to get more. The new field methods were initially envisioned for KIMO, and they should work well there to supplement our existing long-term monitoring.

## Program Goals and Objectives

One of the successes of our fire-effects monitoring program has been its contribution to the development of short and long-term objectives for the prescribed fire program. Monitoring data have been continually used to evaluate and improve objectives, and this is indicative of major advances in understanding Appalachian fire ecology over the past 15 years.

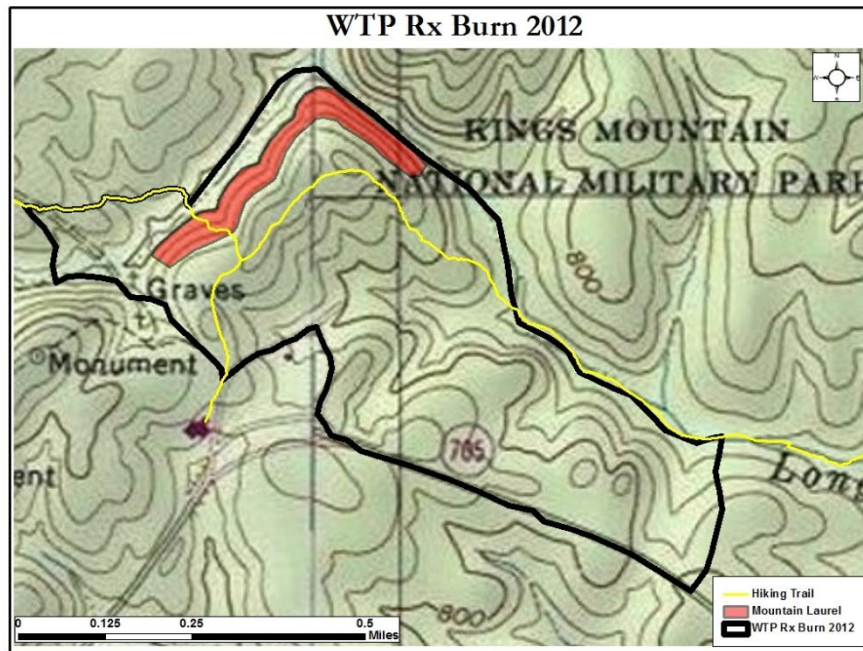
In past years’ reports, we’ve used this space to communicate existing goals and objectives and to improve the objectives as new data have become available. There are no significant changes in goals and objectives for KIMO, so in the interest of reducing the length of this report, the reader is referred to last year’s report which can be found at the SER Fire Sharepoint site.

## Review of 2012 Projects

### WTP (125 acres):

The WTP (Water Treatment Plant) prescribed burn unit is located along Main Park Drive just east of the Visitors Center, and includes forest surrounding the water treatment facilities. The unit is comprised of a broad ridge on the west side that drops off steeply to the northwest and northeast, and several spur ridges that run northwest and perpendicular to Main Park Drive. Much of the target ridgetop and upper slope forest is chestnut oak (*Quercus montana*) with scarlet oak (*Quercus coccinea*) and patches of shortleaf pine (*Pinus echinata*). Additionally, there is a notable band of 2-3 m tall mountain laurel (*Kalmia latifolia*) that runs across much of the steep northwestern and northeastern slopes of the west ridge.

**Figure 1.** Map of WTP Prescribed Burn 2012



A small portion of this unit was burned on April 7, 2000 as part of the Battlefield prescribed burn, and included the far west of the unit with trails running to the VC forming the north and east boundary (**Figure 1**). Very little information exists on the effects of this first burn but it appears that the area may have burned in a backing fire. The complete unit was burned for the 1<sup>st</sup> time as WTP May 9, 2006. This entry was during a long term drought period, which coupled with some intense ignition patterns resulted in scattered snags and frequent basal wounding of overstory oaks, particularly on the western ridge.

This most recent burn occurred on March 12, 2012 under moderate cloud cover and relative humidity. Ignition patterns generally focused on ridges and upper slopes, and fire was allowed to back across much of the unit (**Figure 2**).

**Figure 2.** Photo of backing fire in 2012 WTP Rx Burn

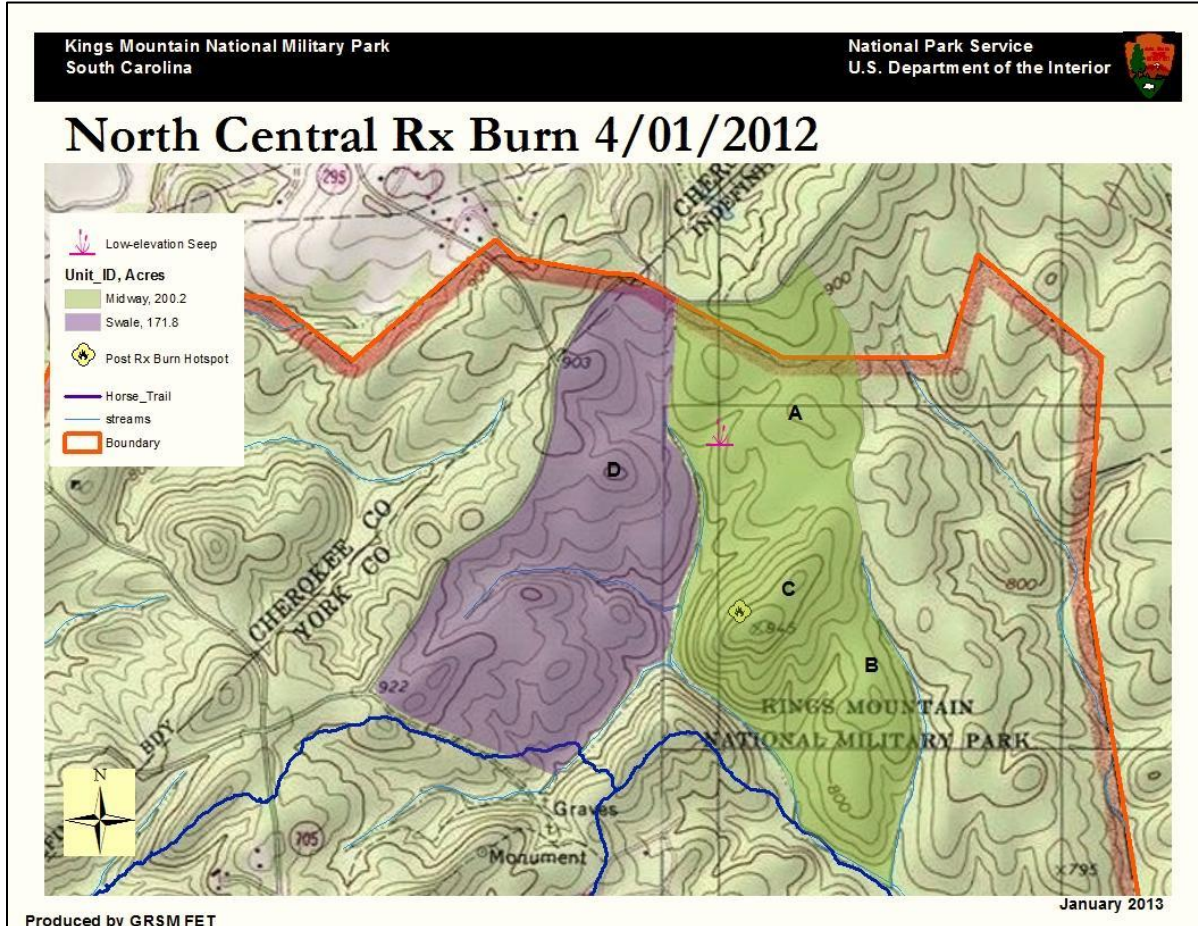


No FMH monitoring plots occur in this unit, but day-of observations and post burn reconnaissance indicate a fairly complete burn across the target areas with overall low severity results. Objectives were met with regard to litter consumption, and they were also most likely met for overstory retention and top-killing of fire intolerant pole size trees. Other interesting effects that were driven by long-term drought included greater consumption of 1000-hr fuels, fire felling of several preexisting snags, and intense torching of mountain laurel resprouts due to low live fuel moisture and live canopy at ground level. Generally, this was a great second burn for this unit with much lower intensity / severity compared to the initial burn. Moreover, there is a clear need to moderate fire intensity when burns are conducted under long-term drought conditions, because effects can quickly become severe even with moderate changes in firing intensity under these conditions.

**North Central (381 acres):**

The North-Central unit was a combination of two previous smaller units called Midway and Swale located in the Northeast corner of KIMO (**Figure 3**). Midway (originally 218 acres) received the first burn on March 24th, 2007 and Swale (originally 175 acres) received its first burn on March 30, 2006. Both of the previous burns, but particularly Midway, were extremely severe and major canopy gaps exist throughout each unit. The canopy gaps have extreme numbers of hardwood resprouts, limited leaf coverage and are surrounded on the periphery by overstory trees with basal scarring. Fuels within the unit were plentiful in places and sparse in others. There was an accumulation of standing dead snags within the canopy gaps that would prove to be a significant factor in firing concerns.

**Figure 3.** Map of North Central. Points A-D are referenced in the report.



The second burn to the combined unit occurred on April 1, 2012 for a total of 381 acres. The unit contains several vegetation types; the site is mostly comprised of Appalachian shortleaf pine-mesic oak, with Xeric ridgetop oak and Southern Blue Ridge pine and oak occupying their respective place on the landscape. 3 other classifications of interest occur in this unit. They are of interest because they are uncommon in the park and elsewhere. They are: Piedmont Rock Chestnut oak-Blackjack oak Woodland, Piedmont Low-Elevation Headwater Seepage Swamp, and Appalachian shortleaf pine-Post Oak woodland.

At the time of implementation, it was known that KIMO had been in a long-term drought and planning efforts were taken to mitigate residual effects from fire and drought. The general plan was to fire the ridges and upper slopes to create low intensity backing fire through most of the unit. Firing/Holding squads along the holding lines were to watch for fire backing off the ridges, drag those fires down slope to the line, and to limit headfires. This was the first implementation of this technique in KIMO's prescribed fire history.

All data discussed within this document came from FEMO reports, data collection visits from post burn and year 1, Qualitative Monitoring, reconnaissance of interior of unit and discussions with the firing boss.

### ***Fire Observations:***

A rain event occurred almost directly over the park and deposited approximately 0.3” of rain which delayed the start time of the burn until 1300 while drying occurred. Weather for the burn was fairly similar to the forecast with temperatures reaching 79 F and a low humidity of 32 %. Cloud cover was predicted to be 75%; most of the day was slightly less cloudy, but a cell passed over the burn during the late afternoon with light precipitation and shut operations down in the evening.

### ***Midway***

Firing started in the Kings Mountain State Park portion of the unit and igniters walked ridgetops along Midway and west along the Swale boundary. The ridgetop ignition seemed to carry after dotting techniques and fire pulled together at low intensity and backed off ridges where fuels were available. The intent of this technique was for fire to become established in available fuels and then back through canopy gap resprouts, limiting further overstory mortality. Fire behavior was minimal due to fuel moistures being higher from previous night’s rain events.

Overall flame lengths were approximately less than 1’ and rates of spread of backing and flanking fires were ½ chains -1 chain an hour in oak litter. Below is an example of backing fire as it proceeded through vegetation in the Blackjack oak type. The fuels on the southern end of Midway had more drying associated with them so consumption was greater.



Figure 2 Midway unit Southwest ridge

Concerns among the Firing crew about overhead hazards led to a decision not to put fire in canopy openings on the southern end of the unit, and those areas did not burn completely the day of the burn. Once the precipitation occurred, operations were shut down for the day and no fire was re-started the next day to treat unburned areas.

### ***Swale***

Firing operations mostly remained along the roads and tried to establish fire where it would carry which was minimal in areas with open canopy, due to light, compacted fuels. Ignition was more successful in areas with a fuller canopy and better litter layer. Igniters had to work pretty hard to

find good fuels that would carry fire for most of the day. Following the late-day precipitation, operations were shut down, and no further ignitions occurred the following day.

### ***Fire Effects:***

2 long-term fire effects plots within the Blackjack oak woodland type occur on the Midway side of the unit, although these plots do not represent the fuels for the entire unit. The fire-effects team conducted substantial reconnaissance and qualitative monitoring of the North-Central unit to assess overall fire effects.

The following effects were noted from both units following the initial Prescribed Burn:

- The burn was mostly a light burn, as desired
- This severity was expected given the ridgetop ignition plan
- In the north part of the Midway side (**Position A, figure 3**), fire backed through ridgetop canopy gaps and resulting effect was top-kill of unwanted hardwood resprouts.
- Southeastern ridge in Midway (**Position B, figure 3**) received little ignition in canopy gaps and as a result had no fuel consumption and insufficient hardwood top-kill.
- Main ridge (**Position C, figure 3**) in Midway had fairly uniform coverage along the immediate ridge and top 1/3 of slope
- Swale unit and upper Long Branch creek drainage that divides unit, had large pockets of unburned fuels as seen from post burn scouting mission
- Lower part of drainages dividing units received hot fire from previous burn and no canopy exists, intense regeneration exists and fire may have only top-killed stems less than 2 meters tall
- In Swale unit(**Position D, figure 3**), fire remained on upper thirds of slope, and consuming top layer of litter with scattered 1 and 10 hour fuels
- It was observed post burn that extremely good fire effects occurred in Post oak/ Black needle grass areas with regards to top-kill of woody stems and limited new basal damage to oaks.
- Fire sensitive seepage area has had noticeable damaging effect from previous fire, but remained unburned during 2012 burn(noted on map as **Low-elevation seep**)

The following effects were noted from sites that experienced an extended burn resulting from untreated fuels and long-term drying event:

- Smoke column was reported from the unit 2 weeks from initial burn date. It is thought to have come from just north of Position C on the map
- Area is approximately 3-5 acres, indicated on map by Hotspot icon, the location of a new canopy gap. Appeared to be Head /flanking fire from bottom of drainage. The fire produced 3-8 meter char on oaks. Below is an image of charred 1000 hour fuels.



Located below Hotspot symbol on map

- Hardwood re-sprout response is moderate to heavy in this area
- High herb response for colonizer plant Fireweed(*Erechtites hieracifolia*) along drainage
- Litter fuel loads in drainage either non-existent or diminished greatly. Duff consumption in the general “hot spot” area was low-moderate based on field notes and observations
- Mechanical treatment areas appeared to not have carried fire very well

#### **Comments/Recommendations:**

A success story for the North Central burn was the obvious level of planning that went into preparing for the burn. A successful ignition strategy was planned and implemented the first day. Initial techniques were developed and discussed to achieve good fire spread, top-kill hardwood resprouts, and minimize any further overstory mortality. Fire staff was, for the most part, in sync with the plan.

Continued fuel reduction and hardwood resprout top-kill was mostly effective in this unit. A light/low intensity treatment of Oak forests on the initial burns is a desirable outcome. The main shortcoming of the North Central burn, from a fire effects standpoint, were the failures to ignite the canopy gaps on the day of the burn and the failure to re-ignite the unburned sections the following day. It would have been beneficial to treat fuels when spread concerns were minimal and igniters could have mitigated the long term drying and long term smoke concerns. This may have potentially limited any further overstory mortality that was created.

Based on the effects observed on North Central, it may be wise to monitor long term drought indices for future burns. Pay particular attention to days since rain and expected next rainfall and amount. In particular, this part of South Carolina has been in an extended drought. Though the unit received light rain both the night before and night of the burn, the area has been subject to deep drying and it did not rain for two weeks following the burn.

Other finds to note were the observation of several ground nests from the Eastern whip-poor-will during and after the burn. All the nests had eggs in place, and these were generally in areas that did not burn. This is thought to be a good thing in terms of bird conservation. Whip-poor-wills are not uncommon, but numbers of them have declined in regions north of South Carolina due to increased canopy density and less open understory.

## Long Term Monitoring Results

2009 was the last time that long-term monitoring results for KIMO were updated (**Table 1**), but there was not enough data collected during 2012 to improve the current analysis. As noted before, the results indicate that KIMO is on track toward achievement of its management objectives. Despite the large number of plots at KIMO, however, there are significant trends in fire effects that are not being captured in the plot data.

**Table 1.** Objectives and long-term monitoring results for KIMO

| Monitoring Type                                                           | Management Objective Restoration Phase- (After 4 burns) | Monitoring Results (80% confidence intervals)                                                                                       | Objective Achieved?                   | Year Last Analysis Completed |
|---------------------------------------------------------------------------|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|------------------------------|
| <b>Chestnut Oak-Blackjack Oak Woodland (FQUMA1)</b><br><br><i>8 plots</i> | >50% Reduction in total fuel loading                    | Total fuel reduction:<br>After one burn = 47% ( $\pm 4\%$ )<br>(n=7)                                                                | <b>Not yet, but on course.</b>        | <b>2009</b>                  |
|                                                                           | >70% Reduction in pole-sized tree density               | Pole reduction:<br>After one burn = 45% ( $\pm 12\%$ )<br>(n=8)<br>After two burns = 62% ( $\pm 12\%$ )<br>(n=4)                    | <b>Not yet, but on course.</b>        | <b>2009</b>                  |
|                                                                           | 15-30% Reduction in overstory tree density              | Overstory reduction:<br>After one burn = 30% ( $\pm 11\%$ )<br>(n=8)                                                                | <b>Yes</b>                            | <b>2009</b>                  |
|                                                                           | >30% Cover by native herbs                              | Preburn cover: 6%<br>Cover after 1 burn: 9%<br>(n=7)                                                                                | <b>No, but more burns are needed.</b> | <b>2009</b>                  |
| <b>Dry Oak Forest (FQUMO1)</b><br><br><i>21 plots</i>                     | >50% Reduction in total fuel loading                    | Total fuel reduction:<br>After two burns = 41% ( $\pm 5\%$ )<br>(n=19)                                                              | <b>Not yet, but on course.</b>        | <b>2009</b>                  |
|                                                                           | >70% Reduction in pole-sized tree density               | Pole reduction:<br>After one burn = 43% ( $\pm 2\%$ )<br>After two burns = 58% ( $\pm 5\%$ )<br>(n=19)                              | <b>Not yet, but on course.</b>        | <b>2009</b>                  |
|                                                                           | 15-30% Reduction in overstory tree density              | Overstory reduction:<br>After one burn = 7% ( $\pm 3\%$ )<br>After two burns = 12% ( $\pm 3\%$ )<br>(n=19)                          | <b>Not yet, but on course.</b>        | <b>2009</b>                  |
|                                                                           | >200 tall (>1m) Oak or shortleaf pine seedlings/acre    | Preburn density = 85/ac ( $\pm 49$ )<br>After one burn = 55/ac ( $\pm 34$ )<br>After two burns = 55 stems/ac ( $\pm 32$ )<br>(n=19) | <b>No, but more burns are needed.</b> | <b>2009</b>                  |
|                                                                           | >15% Cover by native herbs/subshrubs                    | Preburn cover: <1%<br>After 1 burn: 1%<br>After 2 burns: 1-2%<br>(n=19)                                                             | <b>No, but more burns are needed.</b> | <b>2009</b>                  |

The greatest concern with the prescribed fire program remains excessive overstory tree mortality in some locations. These high-mortality events are the greatest impediment to meeting our long-term objectives for fuels management and forest health management at KIMO. Accordingly, the fire effects team, over the past three years, has prioritized collection of pre-fire qualitative data to

support planning and effective implementation. We have also attempted to conduct thorough post-burn monitoring and effects analysis for recently-completed burns to support future burn planning. Examples of this kind of monitoring and analysis can be found in annual reports from this year and the past several years. In addition, this year's BISO report features a detailed analysis of overstory mortality that has some applicability to the oak forests at KIMO.

## **Program Review and Discussion**

The number of trips made to KIMO in 2012 was a big departure from previous years, when an average of 7-8 trips were made, typically including 4 weeks to conduct long-term monitoring during the summer/fall. The reduced number of visits is a direct reflection of reduced budgets, and it appears these reductions in funding will continue into the foreseeable future. What this means is that our large workload at KIMO will need to be tightly prioritized.

Based on the assumption of funding 1-2 weeks of monitoring field work at KIMO, we will likely prioritize our work in the following way:

1. Pre-burn scouting and planning to support upcoming burns
2. Implementation of alternative monitoring protocols in previously burned areas (see alternative monitoring sections in the BISO and GRSM reports)
3. Completion of post-burn plot monitoring and post-burn reconnaissance of most recent burn sites
4. Completion of year-2, year-5, or year-10 long-term plot monitoring

Attending all prescribed burns remains a high priority for the Fire Effects team. Please contact the Fire Ecologist for any specific requests or to discuss these priorities.

## D. Fire Ecologist and Fire Effects Crew Accomplishments and Areas of Focus

**Table 1. Fire Ecologist Accomplishments/Focus Areas**

| Category                 | Percent Time | Accomplishments and/or areas of activities                                                                                                                                                    |
|--------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Planning</i>          | 25%          | Planning meetings at nearly every park in the cluster; Burn plan reviews; fire effects program planning; development of site-specific objectives for FY12 burns; Many large and small things. |
| <i>Data Collection</i>   | 15%          | Field work at several parks. Design and testing of alternative monitoring protocol at GRSM and BISO. Plot work and qualitative surveys. Immediate postburn and growing season.                |
| <i>Data analysis</i>     | 15%          | Estimated amount of time spent performing analyses, including data summaries and statistical tests.                                                                                           |
| <i>Research</i>          | 10%          | Continued as Federal cooperator on regional JFSP dendrochronology project and Indiana bat project; Heavy involvement with numerous research projects, mostly at GRSM (see Research Update).   |
| <i>Supervision/Admin</i> | 10%          | Hiring, supervision, travel, payroll, crew support, purchasing etc.<br>For 2012 includes GIS Intern                                                                                           |
| <i>Fire Assignments</i>  | 8%           | Lots of prescribed fire throughout SER. Several wildfires at GRSM.                                                                                                                            |
| <i>Presentations</i>     | 2%           | Talk on prescribed fire management and fire effects at BISO;<br>Talk on fire ecology of GRSM at Tremont Institute; Led Purdue Forest Ecology Field Trip.                                      |
| <i>Interagency work</i>  | 5%           | Steering team/Monitoring committee/DFC committee for Southern Blue Ridge FLN, Annual FLN Workshop.                                                                                            |
| <i>Data management</i>   | 2%           | Various                                                                                                                                                                                       |
| <i>Training</i>          | 3%           | OJT for Firing Boss. Participation in various classes.                                                                                                                                        |
| <i>Miscellaneous</i>     | 5%           | Mostly communication.                                                                                                                                                                         |

**Table 2. Fire Effects Crew 2012 Accomplishments/Focus Areas**

| Category                        | Percent Time | Notes                                                                                                                                                                                                                                                                                                    |
|---------------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>FMH plots</i>                | 25%          | Plot data collecting and preparing plot folders and equipment for field.                                                                                                                                                                                                                                 |
| <i>Prescribed fire projects</i> | 25%          | Crew completed scouting/pre-planning of RX Burn Units and assisted with preparation and operations of prescribed fires in SE region; this includes post-burn monitoring surveys                                                                                                                          |
| <i>Data entry</i>               | 13%          | Data entry and management                                                                                                                                                                                                                                                                                |
| <i>Other plot work</i>          | 11%          | Establishment of photo-plots at CAHA;<br>Development and testing of alternative monitoring protocols                                                                                                                                                                                                     |
| <i>Incident Assignments</i>     | 10%          | <ul style="list-style-type: none"> <li>Lead and 1 crewmember worked as READ on Gulf Oil Spill</li> <li>Members of crew assisted with several in-park (GRSM) wildfires</li> <li>Assistant completed 14-Day Assignment IA Engine Crew</li> <li>Lead worked as READ for Hurricane Sandy Response</li> </ul> |
| <i>Supervision/Admin</i>        | 10%          | Lead and assistant supervised crew and maintained misc travel, time and purchasing paperwork                                                                                                                                                                                                             |
| <i>Presentations</i>            | 1%           | Lead and Assistant presented alternative monitoring strategies at FLN meeting                                                                                                                                                                                                                            |
| <i>CBI plots</i>                | 2%           | Provided CBI training for SHEN crew at Calderwood                                                                                                                                                                                                                                                        |
| <i>Data analysis</i>            | 2%           | Lead and Assistant provided sections for the annual report                                                                                                                                                                                                                                               |
| <i>Training</i>                 | 1%           | Lead and one crew member attended GIS training                                                                                                                                                                                                                                                           |

## E. Additional Program Information

**Table 3. Planning - 2012**

| Park | Does Park have written DFCs?<br>(yes or no) | Date Park-level Monitoring Plan completed<br>(or revised) | Total # of Project- or Community-level Monitoring Plans<br>(not just 2011) | Assisted with how many BAER plans in 2011? |
|------|---------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------------------------|--------------------------------------------|
| BISO | yes                                         | n/a                                                       | 0                                                                          | 0                                          |
| BLRI | no                                          | n/a                                                       | 0                                                                          | 0                                          |
| CAHA | no                                          | n/a                                                       | 0                                                                          | 0                                          |
| CONG | maybe                                       | n/a                                                       | 0                                                                          | 0                                          |
| COWP | no                                          | n/a                                                       | 0                                                                          | 0                                          |
| CUGA | yes                                         | n/a                                                       | 0                                                                          | 0                                          |
| GRSM | yes                                         | n/a                                                       | 0                                                                          | 1                                          |
| KIMO | yes                                         | n/a                                                       | 0                                                                          | 0                                          |

**Table 4. Monitoring - 2012**

| Park | % 2012 Data Entered | % 2012 Data Quality Checked | # Prescribed Fires Monitored* | # Non-fire Fuels Treatments Monitored* | # Wildfires Monitored* | # BAER Treatments Monitored* |
|------|---------------------|-----------------------------|-------------------------------|----------------------------------------|------------------------|------------------------------|
| BISO | 100%                | 100%                        | 5                             | 0                                      | 0                      | 0                            |
| BLRI | 100%                | 100%                        | 0                             | 0                                      | 0                      | 0                            |
| CAHA | 50%                 | 50%                         | 4                             | 0                                      | 0                      | 0                            |
| CONG | 100%                | 100%                        | 3                             | 0                                      | 0                      | 0                            |
| COWP | 100%                | 100%                        | 1                             | 0                                      | 0                      | 0                            |
| CUGA | 100%                | 100%                        | 3                             | 0                                      | 0                      | 0                            |
| GRSM | 100%                | 100%                        | 2                             | 0                                      | 3                      | 1                            |
| KIMO | 100%                | 100%                        | 4                             | 0                                      | 0                      | 0                            |

\* Number of treatment units with treatment effects monitoring conducted. Include pre-burn and post-burn monitoring but not burn-day monitoring.

**Table 5. Communicating Results - 2012**

| Park | # of Project Monitoring Reports completed in 2012 | # of Annual meeting(s) with Park staff | # of Formal presentations of results | Do you use Minitab?* |
|------|---------------------------------------------------|----------------------------------------|--------------------------------------|----------------------|
| BISO | 1                                                 | 1                                      | 1                                    | Yes                  |
| BLRI | 0                                                 | 0                                      | 0                                    | Yes                  |
| CAHA | 1                                                 | 1                                      | 0                                    | Yes                  |
| CONG | 0                                                 | 1                                      | 0                                    | Yes                  |
| COWP | 1                                                 | 0                                      | 0                                    | Yes                  |
| CUGA | 2                                                 | 1                                      | 0                                    | Yes                  |
| GRSM | 2                                                 | 1                                      | 1                                    | Yes                  |
| KIMO | 2                                                 | 1                                      | 0                                    | Yes                  |

**Table 6. Research - 2012**

| <b>Park</b> | <b>Are research needs identified in FMP or Monitoring Plan?<br/>(yes or no)</b> | <b># of Proposals Submitted in 2012</b> | <b># of Proposals Funded in 2012</b> | <b># of Research Projects Supported in 2012*</b> | <b>Additional Comments</b> |
|-------------|---------------------------------------------------------------------------------|-----------------------------------------|--------------------------------------|--------------------------------------------------|----------------------------|
| BISO        | yes                                                                             | 1                                       | 0                                    | 0                                                |                            |
| BLRI        | yes                                                                             | 0                                       | 0                                    | 0                                                |                            |
| CONG        | yes                                                                             | 0                                       | 0                                    | 0                                                |                            |
| COWP        | yes                                                                             | 0                                       | 0                                    | 0                                                |                            |
| CUGA        | yes                                                                             | 0                                       | 0                                    | 0                                                |                            |
| GRSM        | yes                                                                             | 1                                       | 1                                    | 7                                                | Heavy support              |
| KIMO        | yes                                                                             | 1                                       | 0                                    | 0                                                |                            |

\*Number of funded research projects, new or ongoing, supported by the fire ecology program including logistical info or support, staffing, etc.

## Appendix A. Fuels Reserve Research Proposal

**Note:** The objectives, importance to management, and methods described in this proposal are highly relevant to our long-term monitoring of fire effects in several parks, namely our Appalachian parks. This project proposal grew out of monitoring methods that were being designed and tested by the GRSM Fire-Effects Program, and pending approval, these methods will be used for monitoring in several of our parks in coming years.

### I. Title Page

|                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Project Title: Evaluation of Multi-Temporal Burn Severity Maps for Prediction of Fuels Treatment Effectiveness and Plant Community Response Following Burns in the Great Smoky Mountains National Park</b> |
| <b>Lead Investigator Name: Dr. Laura Dewald</b>                                                                                                                                                               |
| Affiliation: Western Carolina University                                                                                                                                                                      |
| Address: Biology Department, 231 Natural Science, Western Carolina University, Cullowhee, NC 28723                                                                                                            |
| Contact Telephone Number: 828-227-2478                                                                                                                                                                        |
| Email: ldewald@email.wcu.edu                                                                                                                                                                                  |
| <b>NPS Project Cooperator Name: Rob Klein, Fire Ecologist</b>                                                                                                                                                 |
| Name of Park , Regional, or National Office: Great Smoky Mountains National Park                                                                                                                              |
| Contact Telephone Number: 865-430-4751                                                                                                                                                                        |
| Address: 107 Park Headquarters Road, Gatlinburg, TN 37738                                                                                                                                                     |
| Email: rob_klein@nps.gov                                                                                                                                                                                      |
| <b>Project Duration</b> (number of months): 18                                                                                                                                                                |
| Approximate Start Date: October 15, 2012                                                                                                                                                                      |
| Approximate End Date: May 15, 2014                                                                                                                                                                            |
| Do you have some flexibility with the start and end dates? No                                                                                                                                                 |
| <b>Research Reserve Funds Requested: \$7000</b>                                                                                                                                                               |

### II. Objectives

The proposed study will combine new field data with over 10 years of NPS fire effects monitoring to evaluate the use of multi-temporal burn severity data (NBR) to make both short and longer-term fire effects predictions at a range of spatial scales in the Great Smoky Mountains National Park. To accomplish this goal, this proposal will address the following questions:

1. What is the relationship between multi-temporal burn severity maps and field-based observations of effects on vegetation and fuels for selected prescribed fires and wildfires occurring over the past 10 years?
2. How does this relationship vary between different fuel types, site, season of fire, and time since fire?

3. *Can multi-temporal burn severity maps be used to make predictions about fuel treatment lifespan, effectiveness and post-fire vegetation dynamics at a range of spatial and temporal scales?*

To answer these questions, existing burn severity maps, existing field data, and new field data will be combined to compare burned sites with untreated control sites. These data will allow us to develop burn severity thresholds and analyze the statistical relationships between severity class, timing of burn, differences in fuel loading/fuel type, effects on vegetation, and vegetation dynamics. The proposed research will be developed as an M.S. thesis project by a current graduate student, Scott Abila. As such, it is also expected that further questions will be developed that may lead to a more robust examination of the role that remote sensing could play in eastern fire ecology.

### **III. Importance of Research for Fire Management**

Great Smoky Mountains National Park has used prescribed fire and naturally-occurring wildfires to manage fuels and vegetation since 1997. As directed by National Park Service policies, these management actions have been monitored by a variety of methods that are designed to assess program effectiveness, detect undesirable trends, and provide data for adaptive management. Ability to achieve these monitoring goals is constrained by high levels of variability in forest type, condition of preburn vegetation, fuel availability during burn events, and ignition type. As a result, while trends in treatment effectiveness and post-burn vegetation dynamics are observable and somewhat predictable, such trends are extremely difficult to quantify with a statistical level of certainty. Further, the sampling design of existing monitoring is not suited to providing reliable or timely data for individual burn sites, which is essential in the practice of adaptive management.

The proposed project will address the FMLB priority area of research that relates to fuels treatment lifespan, effectiveness, and costs. By utilizing existing technology and data (NBR) to quantify fire effects on fuels and vegetation at multiple scales, this research will have direct impact on our ability to measure and predict both the lifespan and effectiveness of fuel treatments at specific sites. While economics will not be explicitly considered, the potential of the research to aid in cost savings through increased efficiency is clear. Not only could monitoring costs be reduced by the development of a predictive model based on existing data sources, but the resulting gains in effectiveness of overall fuels management would provide economic as well as ecological benefits. Other benefits of the proposed research include applicability to many land managers throughout the Central and Southern Appalachians who also have access to multi-temporal burn severity imagery through the Monitoring Trends in Burn Severity (MTBS) program.

### **IV. Methods**

#### Study Area

Vegetation, fuels, and severity data will either be compiled (for existing NPS data) or collected (new data) for burned and unburned sites within Great Smoky Mountains National Park. The wildfires and prescribed fires that will be examined have burned areas less than 1000 acres and include multiple forest types within the burn perimeter. These forest types range from low-elevation Appalachian yellow pine and oak forests to mesophytic oak and hardwood forests. Burn sites are typically located in rugged, dissected landscapes at low elevation (<2500'), with all aspects represented and moderate to steep slopes

(30-70%). All burn sites have unburned areas adjacent to them that can serve as reference sites for comparisons.

### Sampling Design

A total of 14 fires will be examined in the GSMNP, including 7 wildfires and 7 prescribed fires. The park already has existing multi-temporal severity maps (dNBR), and vegetation maps for each of these fires. Placement of field sites will follow a stratified-random design, with severity class and vegetation type serving as selection strata. Twelve plots will be established for each fire, representing 3 blocks of 'no-burn, low severity, moderate severity, and high severity zones' among at least 2 different forest types. A total of 168 new, non-permanent plots will be examined. Additional plot-based data from the park's fire effects monitoring program (over 135 permanent and non-permanent plots) will be used to supplement the data available for analysis.

### Field Methods

Field measurements will be made within a 30m diameter circular plot following the recommended protocols for Composite Burn Index (CBI), Fuel Load (FL), and Species Composition (SC) sampling described in Lutes et al. (2006). Overstory vegetation will be sampled within the full 30m plot, while understory and substrate sampling will occur within a 20m diameter nested subplot.

### Intended Data Analysis

CBI values among different fire severities will be compared to the average dNBR pixel values and relationships tested using regression analyses for each of the following comparisons.

- dNBR and CBI values from wildfires and prescribed fires within the same forest types as well as among different forest types will be compared to see if there is a relationship between dNBR and CBI values among and within ecotypes.
- dNBR and CBI values from different wildfires and prescribed fires occurring during spring and fall will be compared to see if there is a relationship between dNBR and CBI values among different seasons.
- dNBR and CBI values from fires occurring between 2 and 10 years ago will be compared to see if there is a relationship between dNBR and CBI values among fires occurring at different times.

Differences between unburned plots and low, moderate, and high-severity burn plots will be quantified to estimate overall ecological change (OEC) using a diversity index and relationships will be tested using ANOVA analyses for each of the following comparisons. The OEC values will be calculated from comparisons made using FIREMON Analysis Tools (FMAT) (Lutes et al. 2006).

- OEC values will be compared to CBI values from wildfires and prescribed fires within the same forest types and among different forest types to determine if there is a relationship between ecological changes and CBI values among and within forest types.
- OEC values and CBI values from different wildfires and prescribed fires occurring during spring and fall will be compared to see if there is a relationship between ecological changes and CBI values among different seasons.
- OEC values and CBI values from wildfires and prescribed fires occurring between 2 and 10 years ago will be compared to see if there is a relationship between ecological changes and CBI values among fires occurring at different times.
- Fuel characteristics will be measured and compared to dNBR, CBI, and OEC ratings to assess the effectiveness of fuel treatments, in maintaining ecosystem sustainability, among various treatment locations, within and between different ecotypes, during the spring and fall, and with time since fire.

A chronosequence of fuel characteristics will be developed for each of the identified severity levels to evaluate the utility of dNBR for developing predictions about treatment longevity. If time allows, a similar chronosequence may be developed for vegetation structure and composition to evaluate the utility of dNBR for developing predictions about vegetation dynamics.

**Work Cited:**

Lutes DC, Keane RE, Caratti JF, Key CH, Benson NC, Sutherland S, Gangi LH. (2006). FIREMON: Fire effects monitoring and inventory system. USDA Forest Service, GTR-RMRS-164

**V. Deliverables**

| <b><i>Deliverable Type</i></b> | <b><i>Description</i></b>                                 | <b><i>Delivery Dates</i></b> |
|--------------------------------|-----------------------------------------------------------|------------------------------|
| <i>Journal Publication</i>     | <i>Fire Ecology (AFE)</i>                                 | <i>May 2014</i>              |
| <i>Presentation</i>            | <i>International Fire Ecology and Management Congress</i> | <i>December 2013</i>         |
| <i>Presentation</i>            | <i>Great Smoky Mountains N.P. Science Colloquium</i>      | <i>March 2014</i>            |
| <i>M.S. Thesis</i>             | <i>Hardcopy/digital copy to NPS</i>                       | <i>May 2014</i>              |
| <i>Data</i>                    | <i>Field data in FFI database format to NPS</i>           | <i>May 2014</i>              |

*The End*