



Southern Appalachian/Piedmont Fire Effects Monitoring Team

***Fire Effects/Fire Ecology Annual Report
Calendar Year 2010***



A. Summary

The Southern Appalachian/Piedmont fire effects team continued to provide vital support for effective management of public lands in 2010. Aside from completing all short and long-term data collection for the parks within our network (Table 1), the team worked to improve adaptive management by expanding our monitoring strategy to produce site-specific information that can inform planning and operations at the burn-unit scale. Examples of some of the products from this effort can be found in Section E of this report.

Table 1. Fire Effects Plot Workload 2010

Park	Monitoring Type	Type of Plot	Pre-burn	Immed. Post	Postburn (1-20 yrs)	Total Plots
Big South Fork (BISO)	Little Bluestem	FMH Forest plot	0	1	1	4
	Shortleaf Pine	FMH Forest plot	0	0	1	2
	White Oak	FMH Forest plot	0	1	7	11
Cumberland Gap (CUGA)	Scarlet Oak	FMH Forest plot	2	4	8	16
Congaree Swamp (COSW)	Longleaf Pine	FMH Forest plot	0	0	5	5
	Loblolly Pine	FMH Forest plot	0	2	5	5
Great Smoky Mountains (GRSM)	Scarlet Oak	FMH Forest plot	2	1	3	15
	Black Oak	FMH Forest plot	0	0	0	4
	Yellow Pine	FMH Forest plot	1	0	0	35
Kings Mountain (KIMO)	Blackjack Oak	FMH Forest plot	0	0	2	8
	Chestnut Oak	FMH Forest plot	1	6	7	21
	Fuels	Fuels Transect with Photo Points	3	0	0	3
Cowpens (COWP)	Southern Red Oak	FMH Forest plot	0	0	0	2
Blue Ridge Parkway (BLRI)	Chestnut Oak	FMH Forest plot	2	0	0	2
Moore's Creek Battlefield (MOCR)		Photo Point	1	1	0	1
Cherokee National Forest	High Elevation Oak	Modified FMH Forest	0	0	0	3
Pisgah National Forest	Pine-oak-heath	Modified FMH Forest	0	0	0	2
Total			10	16	39	139

As in seasons past, the fire effects team contributed heavily to prescribed fires throughout the Southeast Region and wildfire operations at the home park, participating in at least 23 prescribed burns at eight different NPS units, and supporting effective management of the Calderwood Wildfire at GRSM. Two team members also supported the federal government's response to the Gulf Oil Spill disaster by serving as Resource Advisors for a combined 5 weeks (Table 2). We were blessed with a stable team roster in 2010, and each team member was able to fill at least one critical training need.

Table 2. Fire Ecology Staffing 2010

Staff	Starting Date	Ending Date	# of Pay Periods	READ Qualified (Yes or No)	Training and Development
Rob Klein Fire Ecologist	1/1/10	12/31/10	26	No	Crew Boss Academy(S-230, L-280, S-234, I-200), Gulf Oil Spill 21-Day Detail (READ)
Wylie Paxton Lead Monitor	1/1/10	12/31/10	26	Yes	READ Training, Southeast Region HECM Detail, Gulf Oil Spill 14-Day Detail (READ), Calderwood WF 14 Day Assignment
Matthew Wood Assistant Lead Monitor	1/1/10	12/31/10	26	No	Intermediate Level GIS Training, Southeast Region HECM Detail, Calderwood WF 14+ Day Assignment, Completed ICT5 Taskbook
Bob Dellinger Crewmember	3/10	11/10	18	Yes	READ Training, Calderwood WF 14+ Day
Huma Alvarado Crewmember	3/10	11/10	18	No	GPS Training, Calderwood WF 14+ Day

Additional Fire Ecology/Fire Effects program highlights from CY 2010 include:

- Focusing on crew safety by conducting pre-season training and implementing new standards for engaging in plot work in hazard tree areas
- Building a geo-database that depicts the location of all fire-effects plots in our network
- Presenting “Cracking a Few Eggs” (an adaptive management case study) at the 2010 NPS Fire and Aviation Management national meeting in San Antonio, TX
- Communicating better short and long-term objectives, burning guidelines, and monitoring results to both the CUGA and GRSM Wildland Fire Modules during pre-season meetings
- Creating new ways to monitor and document fire effects at the burn-unit scale, and generating paper and digital files that will build institutional knowledge about each burn unit
- Facilitating the start of a prescribed fire program at Blue Ridge Parkway (BLRI)
- Initiating a fire effects monitoring program at BLRI
- Presenting “The Grit and the Glory” (using fire as a restoration tool) for the Brown Bag seminar series at GRSM – this one is for sale if you’d like a copy!
- Site visits and planning support for Moore’s Creek NB and Carl Sandburg NHS
- Coordinating CBI (Burn Severity Monitoring) workshops at Mammoth Cave NP and GRSM with Fire Effects teams from Natchez Trace Parkway and Shenandoah NP.
- Acting as Federal Cooperator for two Joint Fire Science Program research projects (Fire History of the Southern Appalachians, Impacts of Prescribed Burning on Indiana Bats)
- Participating on the steering team, monitoring committee, and desired-future condition committee of the Southern Blue Ridge Fire Learning Network (FLN)

Research Opportunities

We are fortunate in the Fire Management world to have a few potential sources of funding for research projects. Research, of course, is a great way to develop a scientific foundation for management actions or just to find answers to critical questions that we can't address through monitoring. Our team is currently involved in two research projects, both funded by the Joint Fire Science Program (JFSP) and both with broad applicability across the Southern Appalachians. One is examining fire history at a range of scales in the Southern Apps, while the other is seeking to determine the relationship between fire and the ecology of endangered Indiana bats. A new project to map pre-settlement vegetation and fire regimes at BISO has recently been awarded funds through the NPS Fuels Research Reserve Fund, and we are anxiously awaiting the start of that project. Finally, the NPS Combined Call offers another avenue to seek funding for fire/resource-management related topics. Each of these three funding sources has a call for proposals due in November.

There are several research needs that come immediately to my mind, and I'm sure that the Fire and Resource Managers at our network parks could come up with more. In the coming year, I'd like to try and work with folks in the network to develop a list of research needs and ideas, so that we can look for partners (universities) and develop those needs and ideas into research questions, proposals - and ultimately into research projects. Please feel free to contact the Fire Ecologist with any needs, ideas, or questions that you might have about fire research in your park. Of course there is no guarantee that we can find the right researcher or secure adequate funding, but it's in our interest to at least articulate our needs.

B. Management Objectives and Monitoring Results 2010

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

- an update on fire effects monitoring and fire ecology activities
- current prescribed fire goals and objectives
- a review of 2010 prescribed burns
- analysis of long-term fire-effects monitoring data.

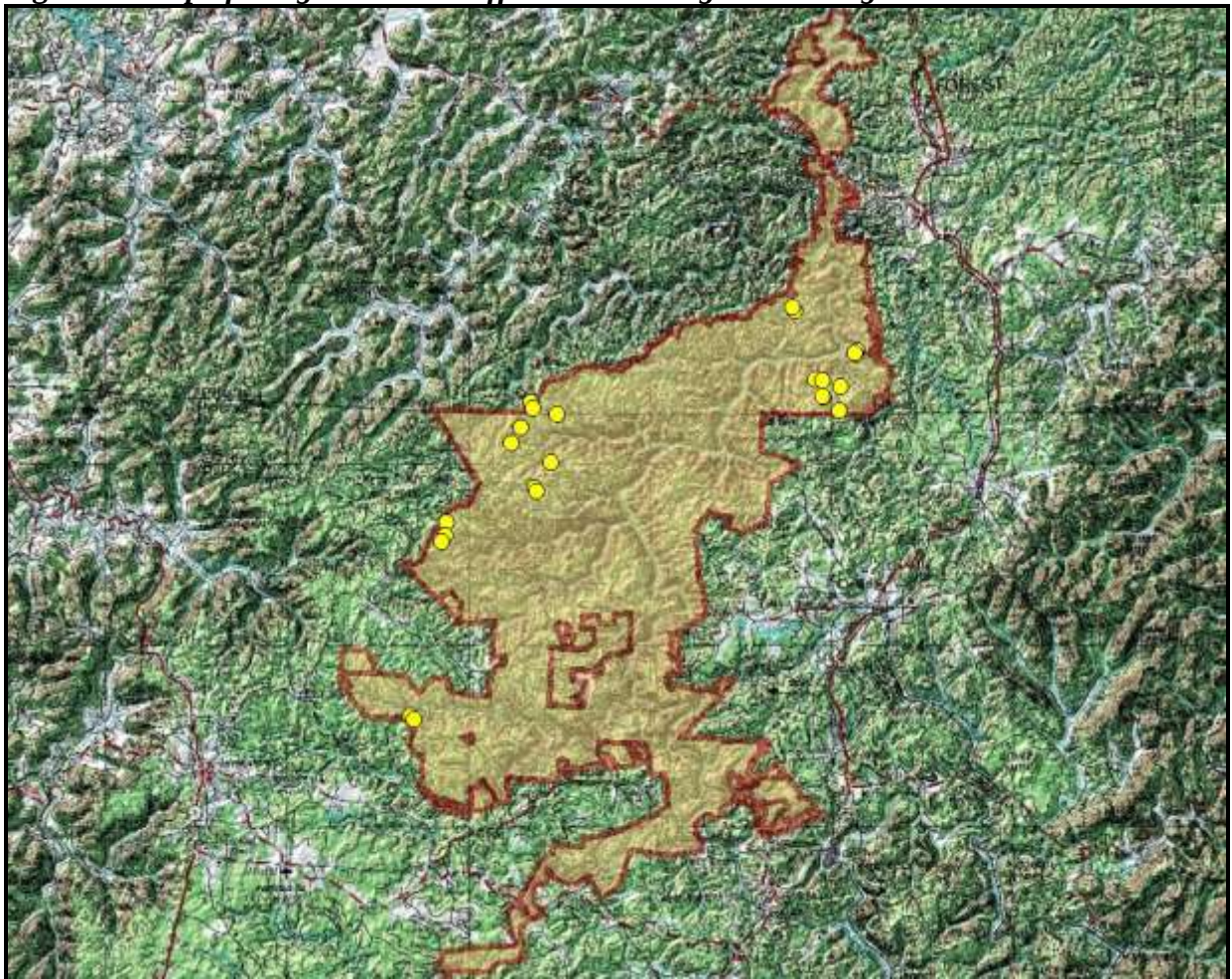
A new analysis of long-term monitoring results has only been completed for parks that have burned new plots over the past two years. A new column in the monitoring results table indicates when the latest analysis was completed. As always, park resource and fire managers are encouraged to address any additional fire-effects questions or needs to the Fire Ecologist or Lead Monitor.

Big South Fork National River and Recreation Area (BISO): 2010 Fire Effects Monitoring Annual Report

I. Overview

The monitoring crew completed all scheduled plot visits in CY2010, except for a single plot at Bald Knob that contained a large number of hazard trees. Most of the field work over the past year centered on the continued post-burn monitoring of a large number of plots in Gobblers Knob A & B, and some additional work was done at Darrow Ridge, which was prescribed-burned for the second time this spring. No new plots were installed in 2010, though there remains a strong desire to install additional pre-burn plots in the enlarged Bald Knob unit, if the park decides to burn it. The fire effects team has recently completed work on building a geo-database that can be used in a GIS to show the locations of all fire effects monitoring plots (see Figure 1).

Figure 1. *Map of Long-Term Fire Effects Monitoring Plots in Big South Fork NRRA*



It bears repeating from last year's report that data from BISO were used in presentations that were given at the International Fire Congress in November of 2009 and the NPS Fire and Aviation Management (FAM) meeting in February 2010. In particular, the presentation given at the NPS FAM meeting focused on the adaptive management process at BISO, touting the Gobblers Knob burn as an outstanding achievement.

Fire Ecology support for BISO over the past year centered on continued efforts to support the park's decision-making process on the 5-year prescribed fire schedule. Another key area of focus over the past year has been in the development and improved communication of site-specific objectives for upcoming burns. The key issue that was highlighted by the FAM presentation was the need to have objectives and prescriptions that take into account the individual condition of each burn unit, as opposed to a generic set of objectives and guidelines. It also made clear the need to communicate these site-specific objectives and prescriptions in a durable way to all burners. To that end, maps and 1 page briefings on site conditions and objectives have been created for upcoming burns (Bald Knob), and should be incorporated into burn planning and day-of-burn briefing of burn personnel. Please see section E for examples of these new products. These documents should help ensure positive outcomes, though we still face the challenge of making sure that all "decision-makers" on burn day understand the park's objectives and expectations.

II. Program Goals and Objectives

The following goals and objectives constitute the general aims of the BISO prescribed fire program, broad guidelines for achieving restoration over multiple burns, and single-burn objectives that are complementary to achieving the long-term goals. It is important to realize that these objectives (especially the single-burn objectives) may need to be adapted or otherwise changed to meet the needs of a particular burn. This process involves using whatever site-specific data we have at our disposal in conjunction with on-the-ground reconnaissance and discussion of site conditions. Whatever the means, *developing and communicating good site-specific objectives will be critical to our success*, especially as sites that have been burned one or more times may have experienced vastly different fire effects.

Goals – BISO is currently using fire to manage grasslands and upland forests. The primary goals are as follows:

1. Restore and maintain cultural and natural landscapes using fire to reduce woody encroachment into fields. A related cultural and natural resource goal is to encourage/enhance native species within field sites.
2. Effectively manage and reduce large fuels loads resulting from years of fire exclusion and southern pine-beetle damage.
3. Restore and maintain structure, sustainability, and species diversity to oak and shortleaf pine woodlands.

Single - Burn Objectives – Objectives for individual burns will, of course, vary according to fuel type, burn purpose (hazard fuels vs. WUI), or number of burns into the restoration cycle. But in general:

Burn objectives for **fields** are -

- > 80% consumption of fine fuels (=stand replacement) over 90% of unit
- > 70% topkill of woody stems (all size classes)

Burn objectives for **forests** are -

- Consume >75% of surface litter (fine fuels) over >75% of the area occupied by target vegetation. Target vegetation is oak and pine forests found on upper slopes and ridges.
- >30% topkill of saplings (<10cm dbh)
- Limit individual canopy gaps (due to fire) to less than 1/2 acre in size
- Use a range of low-intensity ignition (<4' flame length). In general, fire intensities should not exceed the following spatial proportions:
 - <5% high intensity (FL >8')
 - 5-20% moderate intensity (FL 3-8')
 - 75-90% low intensity (FL 1-3')
- Preferred timing is the dormant season (mid-February through early April). This is especially important during first and second-entry burns. If burning occurs after green-up, it is desirable to have less intensity (lower flame lengths, slower moving fires), and not to burn during a pronounced drought.

Long term objectives – Also called “Restoration-Phase” objectives. These objectives vary by vegetation type and are typically expected to be achieved only after 3-5 prescribed burns. It is estimated that such a restoration cycle will take approximately 20 years. At the completion of this restoration phase *in the oak-woodland vegetation type*, we would like to see:

- At least a 50% reduction in total fuel loading
- Greater than 70% reduction in pole-sized tree density
- A 20-40% reduction in overstory tree density, achieved with newly-formed gaps of less than 1/2 acre in size
- Greater than 200 tall (>1meter) oak seedlings per acre
- Greater than 30% cover by native herbaceous species

III. 2010 Projects

Darrow Ridge:

BISO completed their second entry of fire into the Darrow Ridge burn unit on March 24, 2010. Darrow Ridge is located in the South-west corner of the Recreation Area. It is bordered by a silt/gravel road that runs from the Northwest tip of the unit continuing below the entire South portion of the unit. The North portion of the unit is bordered by Laurel Fork Creek and Cumberland plateau-gorge type vegetation that is typically mesic in nature.

The Darrow Ridge unit has burned twice previously, in a 2001 wildfire and again in a 2005 prescribed burn. The size of the unit is 600 acres. The unit is composed of mostly forests dominated by white oak (*Quercus alba*), scarlet oak (*Quercus coccinea*) and black oak (*Quercus velutina*). Most of the pine in this unit has been decimated by the southern pine beetle infestation. Occasional glade-type vegetation occurs on the broad, flat ridges that this unit encompasses as well as on rock outcrops. Species that dominate these areas are Post oak (*Quercus stellata*), Pig-nut hickory (*Carya glabra*), black needle grass (*Piptochaetium avenaceum*) and *Danthonia compressa*.

Since the wildfire and previous prescribed fire, this unit has seen a sizeable total acreage of overstory mortality in the areas that occupy the broad flat ridges closest to the road. Usually the areas with the most mortality remain approximately within 100-200 feet of the road and no one patch is larger than $\frac{1}{2}$ to $\frac{3}{4}$ acre. These open stands remain a thicket of hardwood re-sprouts between 1-3 meters tall with a border of more intact, quality oak that has benefited from previous fire.

The ignition started on the North-east end of the unit along Proctor Ridge road and Laurel Fork creek. Black-lining operations started here and were successful at applying mostly backing fire while the helicopter began interior ignition. The fire from the helicopter pulled together well and made for quick ignition. The black-line operation switched to ATV torch once it reached Darrow Ridge Rd. Here, head-fire pulled in off the road to meet up with the helicopter-ignited fire (approx 1-2 chains). This continued for the rest of the unit. Most of the fire observed by the FEMO (difficult to keep up with helicopter) was flanking fire with 1-3' Flame lengths and 80-90% consumption of the litter. The coverage of the burn was approximately 95%. In general, the duff did not burn. Pole-sized trees up to 2" DBH received significant basal heating and were top-killed in 80% of the unit. Areas where canopy gaps were located received significant top-kill of the woody re-sprouts. Overstory Oak in "canopy-gap" areas received peripheral damage, but mortality was kept to a minimum. Char heights are relegated to < 0.4 meter in height. Firing patterns, although reactive on the day of the burn, were well planned and limited creation of additional large canopy gaps. Sandstone glade areas, depending on location, either received little fire or complete coverage.

The two plots located in this unit are different in nature. One of the plots is a typical FMH Forest plot (QUAL), and the other is a customized "glade plot" (10x25m), so the results of fuels could not be compared because the glade plot does not have fuel transects. The results from a very limited sample size are summarized in Table 1, below. These results provide an example of the fire effects observed in the Darrow Ridge unit.

Table 1. Darrow Ridge Fire Effects (n=2)

Burn Status	1000-hr Load	Duff Load	Litter Load	Total Load	% Overstory Mortality	% Pole Mortality
% Change after 2nd burn	+24%	-17 %	-95%	-20%	-3%	-71%

The Fuel loading values were compared between 01yr02 and 02Post reads

The Overstory and Pole mortality were compared between 00Pre and 02yr01

The woody fuel load is showing increase because of formerly killed overstory trees that have fallen and become part of the fuel layer. It is apparent that the portions of Darrow Ridge represented by these plots are moving toward the achievement of the long-term objectives, though it will require continued monitoring and analysis to determine whether oak and pines are regenerating, and whether the herbaceous response is occurring at the desired levels.

IV. Long term Monitoring Results

The Shortleaf pine (PIEC1) vegetation type has been removed from the table this year, due to the extremely small sample size, and our inability to locate additional plots. The team has made a deliberate effort to locate decent pine stands for new plots, but we have not been successful. Locating such areas and continuing to build this dataset remains an important goal for fire effects monitoring. It may be required to develop a new sampling approach to track long-term objectives in *former* pine-dominated areas. One of the existing shortleaf pine plots has been added to the dry oak forest data to increase sample size for analysis.

Data from the dry oak forest monitoring plots (Table 2) indicate that, while most objectives have not been achieved, the program is on course to achieve the desired levels of fuel reduction and pole-sized tree reduction early in the restoration period. These variables are typically the first ones achieved in a prescribed-fire restoration program. Objectives for oak sapling density and native herb cover are lagging responses in the restoration cycle, and it is likely they won't be achieved until the end of the restoration phase. These differences in vegetative responses are to be expected; we are essentially using fire to gradually create suitable habitat for oak regeneration and native herbs. The numbers that we have recorded for overstory reduction may seem a little misleading to those who have observed the high rates of tree mortality in the Divide Road unit, and it is possible that our data underestimate overstory mortality within the program. However, Gobblers Knob makes up a large portion of the burned (and sampled) acres within the park, and it has comparatively little overstory mortality. At any rate, additional plots will be needed to achieve the desired confidence level for some objective variables within the dry oak forest vegetation type, and these additional plots should insure that changes in overstory density are accurately represented.

The results presented in Table 2 for the Sandstone Glade vegetation type indicate good progress toward achieving objectives in those interesting sites, though the sample size is still too low to make any real

inferences. The facts are that good examples of this community type appears to be very uncommon within the park, and, even with the recent vegetation map, we have a poor ability to predict its occurrence. The scarcity of these sites, their species diversity, and the role of fire in maintaining them suggests that areas containing herb-dominated sandstone glades would be a good target for future prescribed burning; if we can locate them.

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

Vegetation Type	Management Objective Restoration Phase- (After 4 burns)	Monitoring Results (80% confidence intervals)	Objective Achieved?	Year Last Analysis Completed
Dry Oak Forest (FQUAL1) 12 plots	>50% Reduction in total fuel loading	Total fuel reduction After one burn = 51% ($\pm 3\%$) (<i>n</i> =8 plots)	Not yet, but very close.	2011
	>70% Reduction in pole-sized tree density ($\leq 15\text{cm dbh}$)	Pole reduction After one burn = 60% ($\pm 9\%$) (<i>n</i> =8 plots)	Not yet, but on course.	2011
	20-40% Reduction in overstory tree density ($>15\text{cm dbh}$)	Overstory reduction After one burn = 5% ($\pm 2\%$) (<i>n</i> =9 plots)	Not yet, but good gradual movement.	2011
	>200 tall ($>1\text{m}$) Oak seedlings /ac	Preburn mean: 117/acre (± 63) Post-burn mean: 126/acre (± 80) (<i>n</i> =9 plots)	Not after a single burn.	2011
	>30% Cover by native herbs	Preburn cover: 12% (± 6) After 1 burn: 12% (± 6) (<i>n</i> =5 plots)	Not after a single burn.	2011
Little Bluestem Sandstone Glade/Savanna (FSCSC1) 3 plots	>70% Reduction in pole-sized tree density	Pole reduction: After one burn = 16% ($\pm 11\%$) After two burns = 30% ($\pm 14\%$) (<i>n</i> =3 plots)	Not yet, but on course.	2011
	>100% Cover by native herbs	Preburn cover: 98% (± 26) After 1 burn: 123% (± 28) After 2 burns: 133% (30) (<i>n</i> = 3 plots)	Yes, but not with 80% confidence	2011

V. Discussion and Comments

The findings provided in this monitoring report suggest that the BISO prescribed fire program is making good progress toward achieving the long-term objectives of the program. To borrow from last year's report, it is still accurate to say that the park's burn program has undergone an impressive adaptive management process within a relatively short span of time (6 years), and has developed an effective approach to managing a difficult hazardous fuels situation (see "Program Goals and Objectives"). Some major challenges remain, including sustaining a landscape-scale restoration program with limited fire staffing, and remaining vigilant about the appropriate use of fire at BISO. Continued monitoring and engagement with all stakeholders remain vital to the success of managing fuels and restoring fire-adapted vegetation at BISO.

Blue Ridge Parkway (BLRI): 2010 Fire Effects Monitoring Annual Report

I. Overview

Calendar year 2010 was the first year for fire-effects monitoring at BLRI. Monitoring activities consisted of establishing two forest plots and pre-burn inventory of invasive-exotic plants within the Haw Creek burn unit. As the prescribed fire program at BLRI is expected to remain fairly small, the focus of monitoring will be to provide site-specific data for both burn planning and results assessment. The longer term goal will be to slowly build a dataset that can provide quantitative information about the program-wide effects of prescribed burning in selected vegetative communities.

II. Program Goals and Objectives

The following goals and objectives constitute the general aims of the BLRI prescribed fire program, broad guidelines for achieving restoration over multiple burns, and single-burn objectives that are complementary to achieving the long-term goals. It is important to realize that these objectives (especially the single-burn objectives) may need to be adapted or otherwise changed to meet the needs of a particular burn. This process involves using whatever site-specific data we have at our disposal in conjunction with on-the-ground reconnaissance and discussion of site conditions. Whatever the means, developing and communicating good site-specific objectives will be critical to our success, especially as sites that have been burned one or more times may have experienced vastly different fire effects.

Goals – BLRI is currently using fire to manage upland forests. The primary goals are as follows:

1. Effectively manage and reduce large fuels loads resulting from years of fire exclusion, especially in the wildland-urban interface.
2. Restore and maintain structure, sustainability, and native species diversity to pine and oak forests.

Single - Burn Objectives – Objectives for individual burns will, of course, vary according to fuel type, burn purpose (hazard fuels vs. WUI), or number of burns into the restoration cycle. But in general, we want to:

- Consume >75% of surface litter (fine fuels) over >75% of the area occupied by target vegetation. Target vegetation is oak and pine forests found on upper slopes and ridges.
- Top-kill >30% of saplings (<10cm dbh)
- Limit individual canopy gaps (due to fire) to less than 1/2 acre in size
- Use a range of **low-intensity** ignition (<4' flame length). In general, fire intensities should not exceed the following spatial proportions:
 - <5% high intensity (FL >8')
 - 5-20% moderate intensity (FL 3-8')
 - 75-90% low intensity (FL 1-3')

- Preferred timing is the dormant season (mid-February through early April). This is especially important during first and second-entry burns. If burning occurs after green-up, it is desirable to have less intensity (lower flame lengths, slower moving fires), and not to burn during a pronounced drought.

Long term objectives – Also called “Restoration-Phase” objectives. These objectives vary by vegetation type and are typically expected to be achieved only after 3-5 prescribed burns. It is estimated that such a restoration cycle will take approximately 20 years. At the completion of this restoration phase *in the montane oak-pine forest vegetation type*, we would like to see:

- At least a 50% reduction in total fuel loading
- Greater than 70% reduction in pole-sized tree or tall shrub density
- A 20-40% reduction in overstory tree density, achieved with newly-formed gaps of less than 1/2 acre in size
- Greater than 200 tall (>1meter) oak or combined oak and yellow pine seedlings per acre
- Greater than 30% cover by native herbaceous species

III. 2010 Projects

There were no prescribed burns completed in 2010.

IV. Long term Monitoring Results

Two FMH (NPS Fire Monitoring Plots) forest plots were installed in the Haw Creek Burn Unit during the summer of 2010. Both plots were randomly located within a broadly defined montane oak-pine community type, which will be identified as the monitoring type “FQUMO” (Forest plots dominated largely by *Quercus montana*). The sampling design for NPS long-term monitoring calls for stratifying plots by broad vegetation type throughout a park’s prescribed burn areas, until an adequate number of plots is achieved to provide results at the desired confidence level at a park-wide scale. Depending upon the selection of future burn units, it is possible that multiple vegetation types may ultimately be monitored within a given park. This sampling design is laid out in detail in the National Park Service “Fire Monitoring Handbook,” which is available for download at: http://www.nps.gov/fire/fire/fir_eco_mon_fmh.cfm. Questions about the monitoring program should be directed to the fire ecologist.

V. Discussion and Comments

Stay tuned for next year’s report.

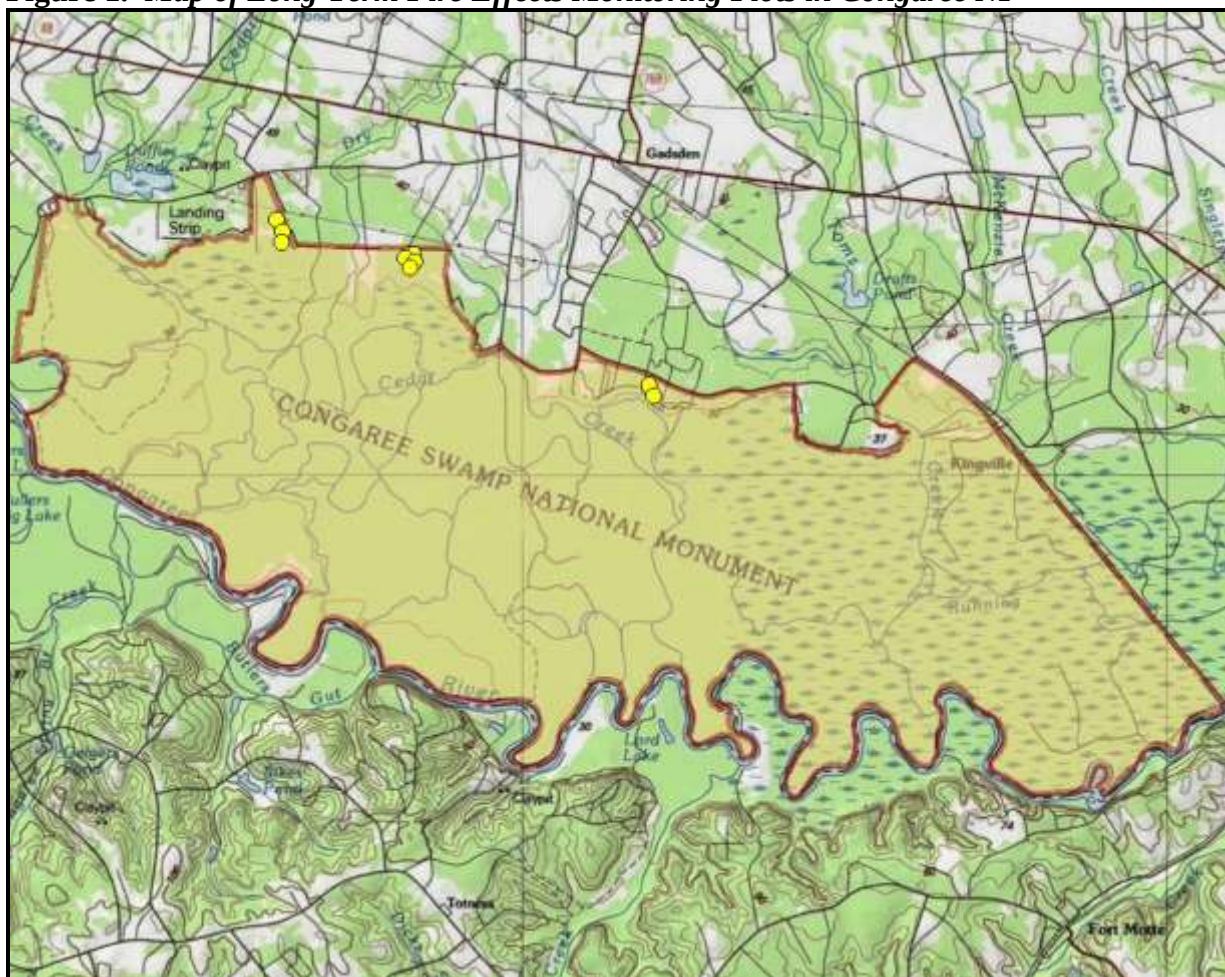
Congaree National Park (CONG): 2010 Fire Effects Monitoring Annual Report

I. Overview

The monitoring crew completed all scheduled plot visits in CY2010. Most of the field work over the past year centered on the continued post-burn monitoring of plots in the RCW and Harry Hampton units, as well as the first actual post-burn reads of plots in the Red Bluff unit. No new plots were installed in 2010, because there are no new burn units scheduled to burn in the coming year. A map showing the location of fire effects monitoring plots within CONG has been provided in this year's report (Figure 1).

Efforts in the coming years will focus on continuing to sample all plots, and looking for opportunities to increase the number of plots. This will remain somewhat problematic due to the lack of additional longleaf sites and the lingering uncertainties about long term goals and objectives for the loblolly-dominated forests. Accordingly, other work will focus on helping to determine meaningful and achievable ecological objectives for these loblolly-dominated areas. The data collected from the Red Bluff burn should be very helpful in this effort.

Figure 1. *Map of Long-Term Fire Effects Monitoring Plots in Congaree NP*



II. Program Goals and Objectives

Goals – CONG is currently using fire to manage upland pine forests. The primary goals are as follows:

1. Restore and maintain all remaining remnants of longleaf pine woodland/savanna, using fire to reduce the density of hardwoods and loblolly pine. A related natural resource goal is to encourage/enhance herbaceous species abundance and diversity within these sites.
Note: This vegetation type is limited to around 70 acres within burn units 3 and 4, much of which has shared dominance by loblolly pine.
2. Restore the woody and herbaceous structure and composition within sites currently dominated by loblolly pine. An analysis of historical vegetation suggests that these areas were once dominated by a variety of longleaf pine natural communities.

Burn Objectives – Objectives for individual burns will, of course, vary according to fuel type, burn purpose (hazard fuels vs. WUI), or number of burns into the restoration cycle, but in general:

Burn objectives for longleaf pine remnants are -

- Reduce the 1-hour fuels between 50-85% over 75% of the unit measured immediately post burn.
- Reduce the density of pole and sapling-sized hardwoods and loblolly pines by 30-70% each burn as measured within 1 year post burn.

Burn objectives for loblolly pine-dominated forests are -

- Reduce the 1-hour fuels between 50-85% over 75% of the unit measured immediately post burn.
- Reduce the density of pole and sapling-sized hardwoods and loblolly pines by 30-70% each burn as measured within 1 year post burn.
- *Induce over-story mortality*, where possible, to as much as 30% as measured 1 year post fire, per burn, without compromising safety and/ or holding concerns.

Long term objectives – Long term objectives are typically expected to be achieved only after multiple prescribed burns. Please see Table 1 below for specific objectives and data.

III. 2010 Projects

Red Bluff / Dawson's Cabin

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. Immediately following the first burn both FMH plots in the Red Bluff were resampled and observed to be unburned. However, when these plots were revisited 1 day prior to the second burn to remeasure fuels, there were obvious signs that both plots had burned during the interim period between burns. No clear information exists

as to the origin of this fire or its immediate post-burn impacts.

The topography of these units can be coarsely divided into 3 areas: the upland pine flats adjacent to Red Bluff Road, the transitional ‘bluff’ area that abruptly slopes down into the floodplain from the upland flats, and the Cedar Creek floodplain/swamp. The upland flats are the target area for these units with a long-term goal of restoring longleaf pine in an open woodland and/or savannah-like setting with increased grass and forb diversity. The current condition of this area, however, is a dense even-aged loblolly pine plantation with relatively low herbaceous abundance or diversity and areas of heavy encroachment from fire-intolerant bottomland hardwoods.

Ignition for this second entry burn was carried out on April 7, 2010 with more favorable weather conditions including less cloud cover and lower relative humidity. Firing was conducted via hand ignition and using an ATV power torch with active ignition restricted mainly to the upland flats and occasionally along the top of the bluff. Black-lining operations occurred primarily along Red Bluff Road with interior igniters eventually covering an area 4-6 chains deep into the upland flat along the road.

Comparatively, this was a better burn than the first entry with regard to percent of the unit burned, continuity of the burn, and overall intensity and severity. General post burn observations indicated that the first 1 to 2 chains off Red Bluff road exhibited the greatest severity with regard to crown scorch and char heights. Further interior on the upland flat severity was observed to be low to moderate with fire carrying fairly continuously through the litter and becoming less active in areas of heavier hardwood encroachment. Post-burn monitoring (Table 1) and general observations suggest most of the litter layer was removed with very little impact to the loblolly pine dominated overstory and moderate severity impacts to the poles (primarily fire intolerant hardwood poles). Duff reduction was likely not as severe as the table suggests because only one of the two monitoring plots showed moderate reduction which might be a localized occurrence, small sample size, and/or error due to differences in personnel taking the measurements. Woody fuel levels were also significantly impacted by a tree that fell in one of the plots post-burn.

Table 1. Fire Effects at Red Bluff (n=2).

Burn Status	1-100 hr Load	1000-hr Load	Duff Load	Litter Load	Total Load	% Overstory Mortality	% Pole Mortality
% Change After 2 Burns	+20%	+157%	-42%	-91%	-34%	3%	63%

Fuel load change compared to 01yr04 fuels data collected 1 day prior to second burn. Overstory and pole mortality compared to preburn.

Objectives for reduction in pole-sized tree density were likely met across the portion of the unit that burned. Woody fuel loading objectives, however, were probably not met with this burn. Additionally, progress on thinning of the loblolly overstory, conversion to longleaf pine, and increasing the number and type of native grasses and forbs was not accomplished in any significant way. Moreover, it is likely that without mechanical removal of at least some of the loblolly overstory, this will be an extremely difficult task to accomplish with prescribed fire alone.

IV. Long term Monitoring Results

The monitoring results for CONG have not been updated for this report. New data are limited to the Red Bluff plots, which have only been burned twice and are not yet compatible with the three-burn data from the Harry Hampton plots. The analysis provided in the Red Bluff burn report above give us a nice summary of the new information that exists from the CONG monitoring program.

It bears repeating from previous annual reports that collection of meaningful fire effects data has been hampered somewhat by lack of an accurate baseline in the RCW unit and lack of clear management objectives for loblolly forests. Other major difficulties include the inability to build an adequate sample size for monitoring of the longleaf remnant. There is simply not enough of that vegetation type at the park to ever achieve a suitable number of plots using the existing NPS monitoring design. With that all said, there is a wealth of data available that can and should be used to help formulate a more meaningful set of management objectives for the use of fire at CONG. Once those objectives are developed, it should be possible to build upon the existing monitoring program to provide better information to park managers. Until such time, the following information provides a glimpse into the successes and shortfalls of the prescribed burning program at CONG. The data need to be viewed with the following caveats:

- The longleaf/loblolly plots included in this analysis are dominated by loblolly pine and are thus not representative of the restored longleaf remnant
- Neither vegetation type has enough plots to accurately describe the range of variability in the vegetation or the fire effects.

Table 1. Long term fire effects monitoring at Congaree Swamp NP

Vegetation Type	Management Objective Restoration Phase- After ?? burns	Monitoring Results (80% confidence intervals)	Objective Achieved?	Year Last Analysis Completed
Longleaf/ Loblolly Pine Woodland (FPIPA1) 5 plots	>50% Reduction in total fuel loading	Fuel reduction after 6 burns: 18% (n=4 plots, 1 burn unit)	No	2008
	15-30% Reduction in overstory tree density	Overstory reduction after 5 burns = 4% ($\pm 16\%$) (n=4 plots, 1 burn unit)	No	2008
	>200 tall (>1m) Longleaf pine seedlings /ac	Preburn density: data not clean After 5 burns: 0 (n=4 plots, 1 burn unit)	No*	2008
Loblolly Pine Forest (FPITA1) 5 plots	>50% Reduction in total fuel loading	Total fuel reduction = 38% Preburn avg.: 33.0 tons/acre After 3 burns: 20.6 tons/acre (n=3 plots, 1 burn unit)	No	2008
	>70% Reduction in pole-sized tree density	Pole reduction: After 1 burn: 38% After 2 burns: 46% After 3 burns: 65% (n=3 plots, 1 burn unit)	No	2008
	25-50% Reduction in overstory tree density	Overstory reduction: After 1 burn: 3% After 2 burns: 3% After 3 burns: 8% (n=3 plots, 1 burn unit)	No	2008

*There is abundant longleaf regeneration within the core of the RCW site; we just aren't picking it up in our plots.

V. Discussion and Comments (Repeated from the 2009 Annual Report)

The park has been successful at meeting the primary goal of restoring the unique remnant of longleaf pine in the RCW unit. A quick walk through that site reveals a diverse and productive herb layer, healthy mature longleaf trees, and abundant regeneration of longleaf pine. Monitoring data from the recently established plot in this restored area can be used as an example of what the park hopes to achieve in other upland restoration projects.

Areas within the RCW site that are currently dominated by loblolly pine have also seen dramatic improvements in woodland structure and herbaceous abundance. These stands in Units 3 and 4 provide some indication that loblolly pine can serve as structural proxy for the longleaf pine community type in certain areas, though reestablishing longleaf pine will require substantially more time or a more aggressive restoration strategy. Still other stands that are closer to the bluff have developed such a dense midstory and understory that getting fire to spread into them has been problematic. Plots in this area indicate that new approaches are needed during prescribed burns: options might include fine-tuning the burn prescriptions or utilizing a helicopter for interior ignition.

It is doubtful that any change in prescribed burning prescriptions or tactics will allow the park to make appreciable progress in reducing the density or basal area of the loblolly pine that dominates most of the burn sites within CONG. Objectives and management strategies will need to be revised to reflect this reality. This process is underway and should be a focus of continued interaction between park managers and regional fire staff in the coming year.

An alarming trend that has been observed during fire effects monitoring over the past couple of years is the increase in wild hog activity in the RCW area. There are now many small and several large wallows and trails throughout even the best longleaf pine site in Unit #4. The effects of this wildlife activity ranges from damage to individual longleaf seedlings and saplings to creation of bare patches that slow or stop the spread of fire during prescribed burns. A result of this kind of soil disturbance is a reduction in native herbaceous cover and diversity, and these areas may contribute to future spread of invasive exotic plants such as *Lespedeza cuneata*, which has been seen throughout the park. The fire effects crew can provide further information about specific hog sightings and large wallows within the RCW area.

Cowpens National Battlefield (COWP): 2010 Fire Effects Monitoring Annual Report

I. Overview

There is very little new information to report for Cowpens. No prescribed burns were conducted during 2010, and there were no scheduled plot reads. Because no new data have been taken, an analysis of objective variables was not warranted, and the results here are repeated from last year's annual report.

Efforts in the coming year will focus on completing a new Biological Evaluation of the effects of prescribed burning on *Hexastylis naniflora* for the US Fish and Wildlife Service. Other work will include looking for opportunities to increase the number of forest plots and developing a monitoring protocol for units that do not have plots. The goal of this protocol will be to map vegetation of interest (high-quality remnants, invasive exotics, rare plants, etc.) and record qualitative notes on fire effects. Accordingly, other work will focus on helping to determine meaningful and achievable ecological objectives for these specific areas of interest.

II. Program Goals and Objectives

Goals – COWP is using prescribed fire to manage grasslands and forests throughout the park. The primary goals are:

1. Restore and maintain the historical battlefield landscape by using fire to reduce woody encroachment into fields. A related cultural and natural resource goal is to encourage/enhance native species within field sites.
2. Restore and maintain the historical structure and species diversity of oak and shortleaf pine woodlands.

Burn Objectives -- Objectives for individual burns will, of course, vary according to fuel type, burn purpose (hazard fuels vs. WUI), or number of burns into the restoration cycle, but in general:

Burn objectives for fields are -

- > 80% consumption of fine fuels (=stand replacement) over 90% of unit
- > 70% topkill of woody stems (all size classes)

Burn objectives for forests are -

- Reduce the 1-hour fuels between 50-85% over 75% of the unit measured immediately post burn
- Reduce the density of pole and sapling-sized hardwoods by 30-70% each burn as measured within 1 year post burn
- Maintain > 80% of existing mature oaks and pines.

Long term objectives – Long term objectives are typically expected to be achieved only after multiple prescribed burns. Please see Table 3 below for specific objectives and data.

III. 2010 Prescribed Burns

There were no prescribed burns completed at COWP during 2010.

IV. Long term Monitoring Results

There is not much to say about long-term monitoring at COWP at this time. The prescribed fire program has been active for only a few years, and there remain only a small number of monitoring plots.

Again, there were no additional data collected during 2010, and the results in Table 1 were not recalculated for this report.

Table 1. Short term fire effects monitoring at Cowpens NB

Monitoring Type	Management Objective Restoration Phase- (After 4 burns)	Monitoring Results	Objective Achieved?	Year Last Analysis Completed
Piedmont Dry Oak Forest (FQUFA1) 2 plots	>60% Reduction in total fuel loading	Total Fuel Reduction = 58% Preburn avg: 30.0 tons/ac Postburn avg: 12.7 tons/ac (n=2 plots, 2 burn units)	No	2008
	>70% Reduction in pole-sized tree density	Pole reduction = 75% Preburn avg: 16 live trees 01yr1 avg: 4 live trees (n=2 plots, 2 burn units)	Yes, but not enough plots	2008
	>200 tall (>1m) Oak seedlings /ac	Preburn avg: not collected 01yr1 avg: 0.5 tall oak seedlings (41/ac) (n=2 plots, 2 burn units)	No	2008
	>20% Cover by native herbs	Preburn cover = not collected 01yr1 cover = <1% (n=2 plots, 2 burn units)	No	2008
	<20 Invasive Exotic plants/ac	Preburn avg: not collected 01yr1 avg: 0 (n=2 plots, 2 burn units)	Not Enough Data	2008

V. Discussion and Comments (repeated from the 2009 Annual Report)

Given the fragmented and successional nature of the vegetation at COWP, it will be difficult to gain quantitative information about the impacts of prescribed burning to any single vegetation type. The decision was made to use a multi-pronged approach to monitoring at COWP, with a limited number of long term monitoring plots, cooperative research, and qualitative observations comprising the monitoring plan. Over time, it is hoped that this approach will yield information and insights that will contribute to the formation of more clearly defined desired future conditions for the fields and woodlands of this park. So far, the results from monitoring suggest three things:

1. Habitat for the Threatened plant *Hexastylis naniflora* **can** burn under prescription conditions – ongoing research should determine the relative harm or benefit to those populations and management decisions should be made accordingly

2. Stands of mature oak and shortleaf pine within the park are limited in size and number; these stands make up some of the best remnant vegetation in the park and efforts should be made to identify these areas and burn them with some care
3. The park likely contains every major invasive exotic plant in the southeast – burn sites will need to be surveyed regularly to ensure that prescribed burning is not exacerbating this problem.

Research Update: Early in 2009, the park received the final research report on fire effects on *Hexastylis naniflora* from the Southern Research Station of the US Forest Service. The findings of the study, in which NPS Fire Effects staff provided training and support, were that:

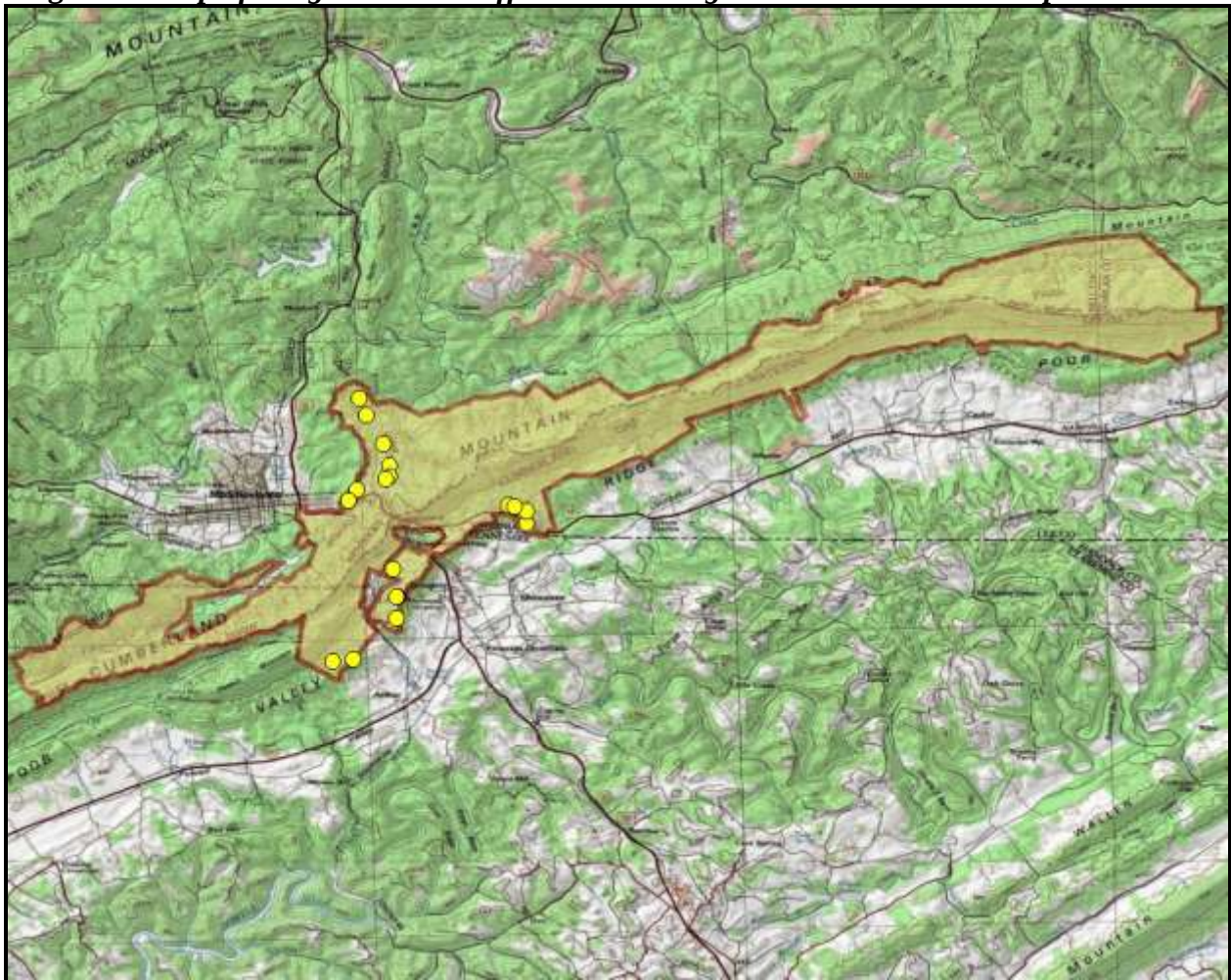
- Burns conducted during “typical” spring prescription conditions were successful at removing litter from the forest floor, but had little impact on the duff layer
- Such fire severity proved to have no effect on mortality or plant size of *H. naniflora*
- Burning during the flowering period (in this case, late April) resulted in loss of annual flower/fruit production for those populations – though the authors suggest that this should not have negative long-term impacts to the populations
- The results of this study should not be used to predict the impacts of repeated burning on these populations – additional monitoring will be needed. **Note: This and the fact that the park has plans that would include potentially burning every *Hexastylis* population, are the primary reasons that USFWS would like for us to rewrite the Biological Evaluation for that species.**

Cumberland Gap National Historic Park (CUGA): 2010 Fire Effects Monitoring Annual Report

I. Overview

The monitoring crew completed all scheduled plot visits at CUGA for calendar year 2010, though full sampling of a plot in Dark Ridge A could not be completed due to hazardous snags, and one of the plots in Dark Ridge C was not sampled because it didn't burn. A large amount of year-1 and year-2 post-burn data was collected including the two new plots in the Hoot Owl Hollow burn unit. Monitoring results for the two units burned during 2010 are discussed in section III below. The crew has also completed a geo-database and maps of all long-term fire effects monitoring plots. The map for CUGA has been included in this report (Figure 1).

Figure 1. Map of Long-Term Fire Effects Monitoring Plots in Cumberland Gap NHP



A key area of focus over the past year has been in the development and improved communication of site-specific objectives for upcoming burns. The key issue that was highlighted by our most recent analyses was the need to have objectives and prescriptions that take into account the individual condition of each burn unit, as opposed to a generic set of objectives and guidelines. It also made clear the need to communicate these site-specific objectives and prescriptions in a durable way to all burners. To that end, maps and 1 page briefings on site conditions and objectives have been created for upcoming burns (Sugar Run B and Hensley A/B), and should be incorporated into burn planning and day-of-burn briefing of burn personnel. Please see section E for examples of these new products. These documents should help ensure positive outcomes, though we still face the challenge of making sure that all “decision-makers” on burn day understand the park’s objectives and expectations.

Goals for future monitoring at CUGA remain to: 1) continue building the oak forest plot network to achieve the 80% confidence level for all variables, 2) expand efforts to monitor exotic plant encroachment into burned areas, and 3) provide the park with monitoring information for other vegetative communities of interest. In the coming year, our team hopes to help with the identification of areas that have high resource values for prescribed burning and also to try and generate some interest in fire research at CUGA.

II. Program Goals and Objectives

The following goals and objectives constitute the general aims of the CUGA prescribed fire program, broad guidelines for achieving restoration over multiple burns, and single-burn objectives that are complementary to achieving the long-term goals. It is important to realize that these objectives (especially the single-burn objectives) may need to be adapted or even changed to meet the needs of a particular burn. This process involves using whatever site-specific data we have at our disposal in conjunction with on-the-ground reconnaissance and discussion of site conditions. Whatever the means, developing and communicating good site-specific objectives will be critical to our success, especially as sites that have been burned one or more times may have experienced vastly different fire effects.

Goals – CUGA is using prescribed fire to manage upland forests, primarily those near developed areas or near the park boundary. The primary goals are to:

1. Reduce and manage fuels in the Wildland-Urban Interface to prevent the spread of unwanted fire off of or onto park lands
2. Restore and maintain natural and cultural landscapes using fire to manage fire-adapted oak and oak/pine forests throughout the park.

Burn Objectives -- Objectives for individual burns will, of course, vary according to fuel type, burn purpose (hazard fuels vs. WUI), or number of burns into the restoration cycle, but in general:

- Consume >75% of surface litter (fine fuels) over >75% of the area occupied by target vegetation. Target vegetation is oak and pine forests found on upper slopes and ridges
- Reduce the density of pole and sapling-sized hardwoods by at least 30%

- Maintain > 80% of existing mature oaks and pines
- Limit individual canopy gaps (due to fire) to less than 1/2 acre in size
- Utilize primarily low-intensity fires (Flame length <4'). Fire intensities should not exceed the following spatial proportions within targeted vegetation types:
 - <5% high intensity (FL >8')
 - 5-20% moderate intensity (FL 3-8')
 - 75-90% low intensity (FL 1-3')
- Preferred timing is the dormant season (mid-February through early April). This is especially important during first and second-entry burns. If burning occurs after green-up, it is desirable to have less intensity (lower flame lengths, slower moving fires), and not to burn during a pronounced drought.

Long term objectives – Also called “Restoration-Phase” objectives. These objectives vary by vegetation type and are typically expected to be achieved only after 3-5 prescribed burns. It is estimated that such a restoration cycle will take approximately 20 years. After this restoration phase *in the oak-woodland vegetation type*, we would like to see:

- At least a 50% reduction in total fuel loading
- Greater than 70% reduction in pole-sized tree density
- A 15-30% reduction in overstory tree density, achieved with newly-formed gaps of less than 1/2 acre in size
- Greater than 200 tall (>1meter) oak seedlings per acre
- Greater than 30% cover by native herbaceous species
- Less than 20 Invasive Exotic plants/ac

III. 2010 Prescribed Burns

Dark Ridge C

Dark Ridge C is the largest burn unit of the Dark Ridge complex at 455 ac, and is located in the northwest corner of the park along the park boundary. The unit is mostly bordered by undeveloped private land with the exception of a housing development along the west line. The topography of the unit is a ridgeline in the shape of an upside-down ‘U’ with several prominent spur ridges descending into the ‘U’, and it is bisected roughly north to south by Shooting Range Road which runs alongside Davis Branch. The target area for this unit is primarily the dry-mesic oak and oak-hickory forest that dominates the main ridgeline, spur ridges, and upper slopes. This unit along with the entire Dark Ridge Complex has a constant threat from exotic plant encroachment due to seed sources on nearby developed lands and old strip mine sites common to the area. Hence, limiting overstory mortality and large canopy gaps has been an important goal for this area.

The first entry of fire into this unit occurred on April 24-25, 2006 with more than 50% of the unit burned, but the top layer of litter was only partially consumed with little removal of duff and low

impact to the overstory. Additionally, only one of the two FMH plots installed in Dark Ridge C burned during the first entry.

Ignition for this second entry burn took place on April 29, 2010 after one drying day following previous days of rain. Due to damp litter conditions and somewhat marginal relative humidity, black-lining operations were patchy and the decision was made to hold fire to the eastern half of the unit along Shooting Range Road and the Davis Branch Drainage. Fire was carried interior onto some of the major south and southwest facing spur ridges in the afternoon with variable results.

Once again only one of the two FMH plots burned during the second entry, but this time it was the plot that had previously remained unburned during the first entry. Table 1 shows the changes in fuels and trees for the one plot that burned during this second entry as compared to preburn data. Overall, fire intensity/severity was low with moderate to high consumption of the litter, but fire spread was generally patchy. The late day interior ignition yielded a slight increase in behavior; however, impacts to the poles and overstory trees were low.

Table 1. Fire Effects at Dark Ridge C (n=1).

Burn Status	1-100 hr Load	1000-hr Load	Duff Load	Litter Load	Total Load	% Overstory Mortality	% Pole Mortality
% Change After Second Burn	+59%	+71%	-17%	-79%	-20%	No Mortality	6%

All data compared to preburn.

Although objectives related to reduction of 1-hr fuels and removal of poles were not met with this burn, the more important objectives of maintaining the overstory and thereby preserving a seed source for future oak regeneration and managing the invasion of non-native plants were accomplished. Additionally, fire was generally applied to the unit in a thoughtful manner despite the limiting weather and fuel moisture conditions.

Hoot Owl Hollow

Hoot Owl Hollow is a 105 ac unit located along the southwest boundary of the park near the town of Harrogate, Tennessee. The unit is primarily bordered by undeveloped private property and a couple of small homes with outbuilding. The topography of the unit is a west-northwest facing slope off a main ridge with a single spur ridge linking the main ridge to a distinct knob in the northwest corner of the unit. The park boundary runs along the main ridgeline on the south side of the unit and a stream runs along the base of the slope on the north side. The ridgeline and upper slopes are composed of dry oak forest, mostly dominated by chestnut and scarlet oak (*Quercus montana* and *Q. coccinea*), with occasional scattered pitch pine (*Pinus rigida*). The mid-slope areas contained more of a mix of dry-mesic oak, commonly including white and black oak (*Q. alba* and *Q. velutina*) mixed with occasional scarlet and chestnut oak. Lower slopes had more mesic mixed hardwoods with some areas of significant rhododendron (*Rhododendron maximum*) understory. Additionally, a notable limestone woodland area with shagbark hickory (*Carya ovata*), chinquapin oak (*Q. muehlenbergii*) and richer herbaceous diversity occurs along steep slopes on the southwest corner of the unit.

Ignition on this first entry burn occurred on April 12, 2010 under borderline low relative humidity. Fire from black-lining operations along the ridgeline carried interior very continuously and at a steady rate of spread even without additional interior ignition. Firing progressed from a central point on the ridgeline with one squad moving to the east and another to the west working fire interior and downslope as needed with operations ultimately tying into the creek at the base of the slope.

The overall results from this burn were generally positive. Post-burn observations and FMH monitoring (Table 2) indicate that this burn generally removed most of the litter with little impact to the duff, and the overstory was left intact while the poles were significantly knocked back.

Table 2. Fire Effects at Hoot Owl Hollow (n=2).

Burn Status	1-100 hr Load	1000-hr Load	Duff Load	Litter Load	Total Load	% Overstory Mortality	% Pole Mortality
% Change After 1 Burn	+42%	-45%	-8%	-100%	-41%	No Mortality	61%

All data compared to preburn.

These were preferable results for a first entry burn and match the objectives for this unit, however burning under such low relative humidities is not ideal for a first entry as evidenced by a canopy gap that was created on the south and west slopes of the knob in this unit. This area of the knob likely experienced some head runs of fire that, coupled with low humidity, resulted in significant removal of the duff layer and a greatly reduced overstory canopy thereby creating a light gap that allowed a very dense invasion of non-native paulownia (*Paulownia tomentosa*) tree seedlings observed in the first growing season following the burn. While this result was only across a small portion of the unit, the point is that working under marginal relative humidities greatly increases the opportunity for negative long term impacts especially if you have an unintentional ignition pattern occur such as an uphill run where it was not desired. Still, the overall results of this burn were good for a first entry under dry conditions which speaks well for the thought that was put into the operations of this project both prior to and during the burn.

Fern Lake A

Fern Lake A is a 16 ac unit located at the western edge of the park by the visitor's center and borders the city of Middlesboro, KY. The unit contains areas of southern pine beetle killed yellow pine and successional hardwoods. Invasive exotic plants are prevalent in this area with Chinese privet and Japanese honeysuckle being to most common species present.

This first entry burn occurred on April 4, 2010 with ignition taking only 2 hours to complete. Very little first-hand fire effects information is available for this unit outside the FEMO report because no members of the GRSM fire effects team were present for the burn and no FMH plots were installed. Apparently, however, severity was generally low due to moderate relative humidities, moist and compact litter conditions, and a predominately eastern aspect, with some increased activity along the ridgeline and in south facing areas.

IV. Long term Monitoring Results

The monitoring data indicate that the prescribed fire program at CUGA has made progress toward achieving the objectives for fuel and tree reduction. It is important to keep in mind that we are giving ourselves 4 burns of each burn unit to achieve these objectives, and that it is desirable to achieve them somewhat gradually. The apparent lack of progress in increasing oak saplings and native herb cover are the same trends we see in nearly all of our plots, regardless of which park. The reason for this is that oak regeneration and herb response are lagging responses in the restoration cycle; that is to say that we don't expect them to improve until we further reduce the fuel loading and tree density. Indeed, in the plots of Dark Ridge A and B, where we had strong fuel and tree density reductions after the first burn, we see some of the best oak seedling and native herb response. These sites are also the ones that have seen some exotic plant invasion, which helps illustrate the need to reduce fuels and trees more gradually.

Table 3. Results of long-term monitoring at Cumberland Gap NHP

Monitoring Type	Management Objective Restoration Phase- (After 4 burns)	Monitoring Results (80% confidence intervals)	Objective achieved?	Year Last Analysis Completed
Dry Oak Forest (FQUCO1) 16 plots	>50% Reduction in total fuel loading	Total Fuel Reduction After 1 burn= 29% ($\pm 3\%$) (<i>n</i> =16 plots)	Not yet, but on course.	2011
	>70% Reduction in pole-sized tree density	Pole Reduction After 1 burn = 39% ($\pm 5\%$) (<i>n</i> =16 plots)	Not yet, but on course.	2011
	15-30% Reduction in overstory tree density	Overstory Reduction After 1 burn = 5% ($\pm 2\%$) (<i>n</i> =16 plots)	Not yet, but good gradual movement.	2011
	>200 tall (>1m) Oak seedlings /ac	Preburn mean: 101/acre (± 12) Post burn mean: 91/acre (± 6) (<i>n</i> =16 plots)	Not yet.	2011
	>30% Cover by native herbs	Mean preburn cover = 2% ($\pm 1\%$) Mean after 1 burn = 4% ($\pm 2\%$) (<i>n</i> =13 plots)	No, but more burns are needed.	2011
	<20 Invasive Exotic plants/ac	Preburn avg: 0/acre Post burn mean: 20/acre (± 14) (<i>n</i> =16 plots)	Unclear due to high variability.	2011

VI. Discussion and Comments

CUGA has developed an outstanding prescribed fire program that has been able to accomplish almost all planned projects and improve the outcomes with each successive burn. The focus should remain on continuing to apply low-intensity/low-severity fire to the landscape, both in areas that have already been burned and new areas that are identified as being benefitted by fire. Invasive exotic plants remain a concern as the program moves forward; however, the monitoring data indicate that these undesirable species are chiefly a concern in areas that experience higher intensity and severity fires (which produce medium to large canopy openings). Of our 16 long-

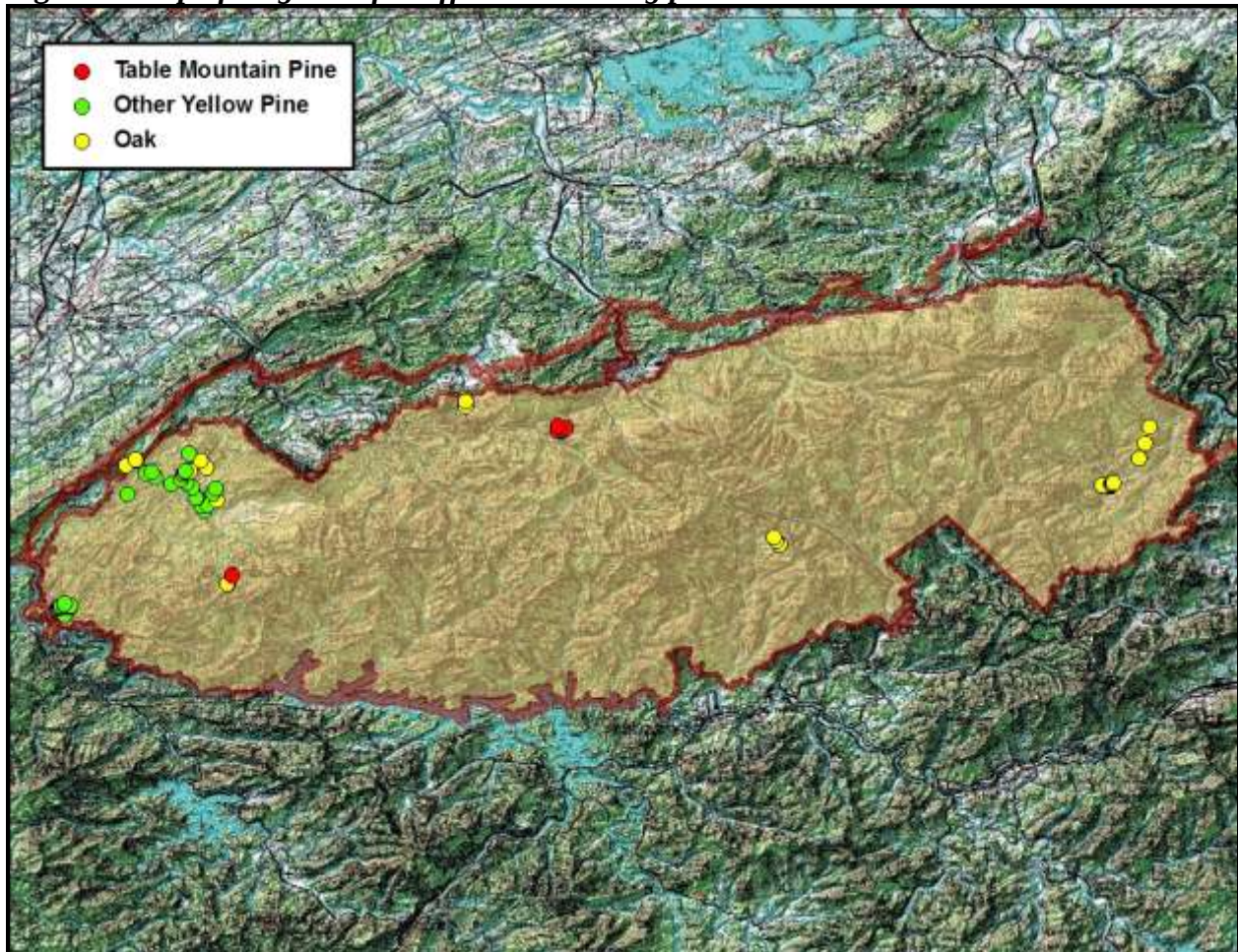
term plots, only two have seen exotic plant invasion - the plots at Dark Ridge A and B. The occurrence of princess tree (in a medium canopy opening outside our plots) following the Hoot Owl Hollow burn re-emphasize the need to plan and implement burns carefully, and to adjust ignitions on the fly according to conditions on the ground during a burn. The single-burn objectives in this report and the site-specific planning documents for upcoming burns are an attempt to increase the knowledge about what we're burning and how best to burn it. Please see Section E at the end of this document for examples of our new site-specific planning products.

Great Smoky Mountains National Park (GRSM): 2010 Fire Effects Monitoring Annual Report

I. Overview

The monitoring crew completed all of the scheduled plot reads at GRSM for calendar year 2010, including the installation of two new forest plots in the Lynn Hollow 2011 burn unit. Aside from completing the standard plot-work, the fire effects crew was an integral part of the overall GRSM fire program, providing leadership on wildfires and prescribed burns, doing a large amount of burn unit prep for GRSM burns, and conducting post fire monitoring for the Cades Cove burns. The crew also completed work on a geo-database and maps of all long-term fire effects monitoring plots. A generalized map for GRSM has been included in this report (Figure 1). Fire ecology support for GRSM in 2010 included these things as well as active participation in fire management planning and the creation of the GRSM RMS Monitoring Conceptual Plan.

Figure 1. Map of long-term fire effects monitoring plots in GRSM.



A key area of focus over the past year has been in the development and improved communication of site-specific objectives for upcoming burns. A critical issue that we have highlighted in our most recent analyses and in last year's annual report was the need to have objectives and prescriptions that take into account the individual condition of each burn unit, as opposed to a generic set of objectives and guidelines. It was also clear that there was a need to communicate these site-specific objectives and prescriptions in a durable way to all burners. To that end, maps and 1 page briefings on site conditions and objectives have been created for upcoming burns (Lynn Hollow was completed for GRSM). These products should be incorporated into burn planning and day-of-burn briefing of burn personnel. Please see section E at the end of this document for examples of these new tools. It is hoped that these products will help ensure positive outcomes, though we still face the challenge of making sure that all "decision-makers" on burn day understand the park's objectives and expectations.

Goals for future monitoring at GRSM remain to: 1) complete all scheduled reads of existing plots while providing for safety first, 2) continue to expand the dry oak forest plot network in future burn units, and 3) continue to build a burn severity (CBI) dataset that can be used in conjunction with spatial data (dNBR) to monitor and model broad-scale fire effects from wildland fires.

II. Program Goals and Objectives

The following goals and objectives constitute the general aims of the GRSM prescribed fire program, broad guidelines for achieving restoration over multiple burns, and single-burn objectives that are complementary to achieving the long-term goals. It is important to realize that these objectives (especially the single-burn objectives) may need to be adapted or even changed to meet the needs of a particular burn. This process involves using whatever site-specific data we have at our disposal in conjunction with on-the-ground reconnaissance and discussion of site conditions. Whatever the means, developing and communicating good site-specific objectives will be critical to our success, especially as sites that have been burned one or more times may have experienced vastly different fire effects.

Goals – GRSM is currently using fire to manage grasslands and upland forests. The primary goals are as follows:

1. Restore and maintain structure, sustainability, and species diversity to pine and oak woodlands
2. Restore and maintain cultural and natural landscapes using fire to reduce woody encroachment into fields. A related cultural and natural resource goal is to encourage/enhance native species within field sites
3. Reduce and manage fuels in the Wildland-Urban Interface to prevent the spread of unwanted fire off of or onto park lands.

Burn Objectives – Objectives for individual burns will, of course, vary according to fuel type, burn purpose (hazard fuels vs. WUI), or number of burns into the restoration cycle, but in general:

Burn objectives for fields are -

- > 80% consumption of fine fuels (=stand replacement) over 90% of unit
- > 70% topkill of woody stems (all size classes)

Burn objectives for forests are -

- Consume >75% of surface litter (fine fuels) over >75% of the area occupied by target vegetation. Target vegetation is oak and pine forests found on upper slopes and ridges.
- Reduce the density of pole and sapling-sized hardwoods by at least 30%
- Maintain > 80% of existing mature oaks and pines
- Use a range of low-intensity fires (flame length <4'). Fire intensities should not exceed the following spatial proportions within targeted vegetation types:
 - <5% high intensity (FL >8')
 - 5-20% moderate intensity (FL 3-8')
 - 75-90% low intensity (FL 1-3')
- Limit individual canopy gaps (due to fire) to less than 1/2 acre in size
- Preferred timing is the dormant season (early March through mid April). This is especially important during first and second-entry burns. If burning occurs after green-up, it is desirable to have less intensity (lower flame lengths, slower moving fires), and not to burn during a pronounced drought.

Long term objectives – Also called “Restoration-Phase” objectives. These objectives vary by vegetation type and are typically expected to be achieved only after 3-5 prescribed burns. It is estimated that such a restoration cycle will take approximately 20 years. After this restoration phase *in the oak-pine woodland vegetation type*, we would like to see:

- At least a 50% reduction in total fuel loading
- Greater than 70% reduction in pole-sized tree density
- A 20-40% reduction in overstory tree density, achieved with newly-formed gaps of less than 1/2 acre in size
- Greater than 200 tall (>1meter) oak or yellow pine seedlings per acre
- Greater than 30% cover by native herbaceous species

Please see Table 2 below for more information on objectives and long-term monitoring data. Note that the objectives above are a bit of a hybrid from our separate oak and pine types.

III. 2010 Prescribed Burns

Canadian Top: Little Cataloochee Church Subunit

Little Cataloochee Church is a small, approximately 100 ac subunit of the much larger Canadian Top Unit. It is located near the eastern boundary of the park in the Little Cataloochee Valley along the east side of the Little Cataloochee Trail. The target area for this first entry burn was the dry-mesic oak dominated ridge running northeast from the Little Cataloochee Church located along the Little Cataloochee Trail.

After 2 false starts due to low relative humidity, ignition occurred on May 6, 2010. Fire carried well along the ridgeline and southeastern slopes, but the northwest slopes and flats along the creeks surrounding the main ridge supported very little fire activity as expected due to moist and compact mixed hardwood litter.

Overall this was a well planned and executed burn. Post-burn observations and FMH plot monitoring (Table 1) indicate that this burn primarily removed the litter with low impact to the duff layer, low impact to poles, and no overstory tree mortality.

Table 1. Fire Effects at Little Cataloochee Church (n=1).

Burn Status	1-100 hr Load	1000-hr Load	Duff Load	Litter Load	Total Load	% Overstory Mortality	% Pole Mortality
% Change After 1 Burn	+77%	-2%	-19%	-95%	-21%	No Mortality	16%

All data compared to preburn.

These results indicate a positive first step toward the long term objectives for this unit with low impact to the existing overstory oaks and gradual removal of the duff layer.

Cades Cove

Cades Cove is located in the northwest end of the Great Smoky Mountains National Park. It is one of the few open grassland areas in the park and is also one of the most heavily visited sections of the park. A seven mile loop road encompasses most of the Cades Cove valley passing by several historic structures. Much of this area was heavily disturbed through conversion of fields to non-native grasses for grazing, drainage of wetland areas, and channelization of streams. Currently the management strategy for this area is to maintain the fields using a combination of mowing viewshed areas adjacent to the roadsides and burning interior fields. A new burn rotation for the Cades Cove fields was implemented in the fall of 2009 and continued for this past fall.

The fall 2010 burn rotation included 5 fields: 3 mid-sized fields including Rowans Creek on the east end, Methodist Church on the north side, and Cemetery Marsh on the west end, and 2 larger fields including Increase Fields located west-central and Tipton-Oliver located on the south side. Rowans Creek was a fairly continuous burn even under areas of thick blackberry (*Rubus* sp.) encroachment. Methodist Church was a uniform burn in the field portion of the unit with

moderate impacts to encroaching pitch pine and Virginia pine (*Pinus virginiana*), and the included strip of adjacent woods was patchy in some areas but likely included some reduction of encroaching white pine in the understory. Cemetery Marsh was also a very continuous burn that was generally successful in top-killing an area of encroaching sweetgum (*Liquidambar styraciflua*) resprouts. The Increase Fields is a larger unit that includes a sizable upland woodlot, a wooded riparian strip, and a sedge (*Carex* sp.) marsh area in addition to the main field portion of the unit. The fields and sedge marsh area both burned uniformly with much of the woody encroachment in the field areas likely being top-killed. Aside from the northern quarter which burn very poorly, the upland woodlot received a continuous spread of fire through the leaf litter with moderate to high reduction of white pine seedling and poles. Fire was somewhat patchy in the riparian woodland with low impacts to the overstory but moved fairly continuously through areas of cured non-native Japanese stilt-grass (*Microstegium vimineum*) which is a common invasive plant in shaded riparian areas throughout Cades Cove. The Tipton-Oliver unit was not completed this fall due to time constraints but is being considered for the spring burn season.

IV. Long term Monitoring Results

Fire effects monitoring has been in place at GRSM since 1997. There are currently 81 plots in six major vegetation types, though only 49 are actively being monitored. There are 9 plots in northern red oak or table mountain pine that have been installed in units that haven't been burned, and 23 grassland plots in Cades Cove that have been suspended due to a lack of clear monitoring objectives. The core of the program at this time is the low-elevation yellow-pine and dry-oak plot networks. Results from the long term monitoring of these vegetation types are provided in Table 2. The results from dry oak forest monitoring have been updated for this report. No significant additions to the yellow pine post-burn data have been made, so most of those analyses have not been updated.

Data from the yellow pine and dry oak forest monitoring plots indicate that, while most objectives have not been achieved, the program is on course to achieve the desired levels of fuel reduction and pole-sized tree reduction early in the restoration period. It is important to keep in mind that we are giving ourselves 4 burns of each burn unit to achieve these objectives, and that it is desirable to achieve them somewhat gradually. The apparent lack of progress in increasing pine and oak saplings and native herb cover are the same trends we see in nearly all of our plots, regardless of which park. The reason for this is that pine and oak regeneration and herb response can all be considered lagging responses in the restoration cycle; that is to say that we don't expect them to improve until we further reduce the fuel loading and tree density. Indeed, in the pine plots of the Tabcat and Wedge Ridge burns, where we had strong fuel and tree density reductions after the first burn, we see some exceptional pine seedling and native herb response. These sites are also the areas where we have seen undesirable levels of overstory mortality and some exotic plant invasion, which helps illustrate the need to reduce fuels and trees more gradually.

Table 2. Long-term fire effects monitoring results at Great Smoky Mountains NP.

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

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

V. Discussion and Comments

Fire-effects monitoring has been in place at GRSM for over thirteen years now, and much knowledge has been gained about the effects of prescribed burning on pine and oak forests in the southern Appalachians. Monitoring data has continually provided information that can be used to refine long-term objectives as well as prescriptions and tactics for individual burns. That being said, the process of restoring fire-adapted natural communities at GRSM is still in its early stages. It is estimated that a minimum of 3-5 burns (20+ years) of each burn unit will be required to meet the restoration objectives laid out in Table 3. With this in mind, it is critical to also use monitoring data to examine individual burns and ensure that short term objectives and effects are supportive of the longer term goals. The brief analysis of the Little Cataloochee Church prescribed burn represents an attempt to use limited monitoring data and more extensive post-burn reconnaissance for this purpose.

With regard to long-term objectives, the park's prescribed fire program has been successful at reducing hazardous fuels and creating a range of structural and compositional effects across the landscape. The mean values for most of the objective variables in pine and oak systems indicate progress in a positive direction, while low overall values for pine/oak regeneration and herbaceous cover illustrate the long-term challenges of restoring these communities. Viewing the pooled data from multiple burns, however, misses the important point that effects vary dramatically from burn to burn and even plot to plot. For example, early burns at GRSM were successful at creating conditions for regeneration of yellow pines, while more recent burns have not yet created these conditions. This is largely a result of altering the seasonality of burning, but it underscores the need to examine fire effects at a range of scales and also to develop objectives at multiple temporal scales. We have attempted to provide objectives for long-term change as well as for individual burn events in the Goals and Objectives section above. We have also worked to develop *site-specific* information and objectives to support upcoming burns (see Section E of this document). We believe that these site-specific objectives provide a critical link to ensure that the effects of individual burns support the achievement of the long-term restoration goals.

a generic set of objectives and guidelines. It is also clear that there is a need to communicate these site-specific objectives and prescriptions in a durable way to all burners. To that end, maps and 1 page briefings on site conditions and objectives have been created for upcoming burns, and should be incorporated into burn planning and day-of-burn briefing of burn personnel. Please see section E for examples of these new products. These documents should help ensure positive outcomes, though we still face the challenge of making sure that all “decision-makers” on burn day understand the park’s objectives and expectations.

II. Program Goals and Objectives

The following goals and objectives constitute the general aims of the KIMO prescribed fire program, broad guidelines for achieving restoration over multiple burns, and single-burn objectives that are complementary to achieving the long-term goals. It is important to realize that these objectives (especially the single-burn objectives) may need to be adapted or otherwise changed to meet the needs of a particular burn. This process involves using whatever site-specific data we have at our disposal in conjunction with on-the-ground reconnaissance and discussion of site conditions. Whatever the means, developing and communicating good site-specific objectives will be critical to our success, especially as sites that have been burned one or more times may have experienced vastly different fire effects.

Goals – KIMO is using prescribed fire to manage oak and pine forests and woodlands. The primary goals are to:

1. Restore and maintain cultural and natural landscapes using fire to manage fire-adapted oak and oak/pine forests throughout the park
2. Reduce and manage fuels to prevent the spread of unwanted fire off of or onto park lands.

Burn Objectives -- Objectives for individual burns will, of course, vary according to fuel type, burn purpose (hazard fuels vs. WUI), or number of burns into the restoration cycle, but in general:

Burn objectives for oak forests are -

- Reduce the 1-hour fuels by at least 50% over 75% of the unit as measured immediately post burn
- Reduce the density of pole and sapling-sized hardwoods by at least 30% each burn as measured within 1 year post burn
- Limit individual canopy gaps (due to fire) to less than 1/2 acre in size
- Maintain > 70% of existing mature oaks and pines.

Long term objectives – Also called “Restoration-Phase” objectives. These objectives vary by vegetation type and are typically expected to be achieved only after 3-5 prescribed burns. It is estimated that such a restoration cycle will take approximately 20 years. After this restoration phase *in the oak-woodland vegetation type*, we would like to see:

- At least a 50% reduction in total fuel loading
- Greater than 70% reduction in pole-sized tree density
- A 15-30% reduction in overstory tree density, achieved with newly-formed gaps of less than 1/2 acre in size
- Greater than 200 tall (>1meter) oak seedlings per acre
- Greater than 15% cover by native herbaceous species

III. 2009 Prescribed Burns

Coneflower/Brushy South

The South Brushy Ridge-Coneflower Rx Burn on 5/18/10 combined two previous burn units for a total of 545 acres. The South Brushy Ridge unit was burned once before in April of 2005. It is bordered on the South by the park boundary, on the West by the Brown's Mountain trail, on the North by a hand line, and on the East by Piedmont Road, where it connects to the Coneflower unit. The Coneflower unit was burned twice before, in May of 2002 and June of 2005. It is bordered on the West by Piedmont Road, the South-East by the park boundary, and the North-East by Main Park Drive and a dirt road.

These units consist primarily of oak and mixed hardwood forests, with scattered yellow pines. The prominent ridge of South Brushy is dominated by chestnut oak and blackjack oak, with a shrub under layer of sparkleberries and blueberries. This particular ridge is significant in the park because the globally rare (G2/G3) vegetation community of Chestnut oak/Blackjack oak woodland is fairly consistent along the ridge. This area is often windswept and sparse of fuels. In contrast, areas below this community type typically had deep pockets of fuel. In one particular location along the South Brushy Ridge side, 1 individual of the exotic invasive Tree of Heaven (*Ailanthus altissima*) was found. It was thought to be, most likely, the result of the first burn, and on the south facing side of the slope, which may have received hotter fire. Location information was given to fire managers at the park.

Many slopes also have a significant shrub layer of laurel, while drainages are more influenced by species adapted to higher moisture. Coneflower has a more level to rolling topography and has more open mixed-oak forests. One significant feature was found in the Coneflower unit that was recorded and information passed to Park managers was the presence of a recently dead, large, multiple old-fire scarred shortleaf pine.

Elevations range between approximately 720' and 980'. There was a significant rain several days before this burn, but the intervening good drying days left finer fuels quite dry and the duff only slightly moist. It bears noting that that this burn did not seem significantly different than other burns that have been conducted at KIMO in the past. The day was slightly warm, rH a little low, clear, not very windy, desires to accomplish burn in 1 day because of smoke issues, black-lining mostly with some interior helicopter ignition using some head fire but mostly flanking and backing fire, and same time of the year are the typical conditions. So to repeat the effects seem rather redundant other than to note a few significant events.

- The South Brushy Ridge side of the burn and especially the slightly lower slopes to the ridge-top may have received hotter fire than necessary. Although this cannot be typically observed 1 year post burn.
- The South Brushy Ridge top itself probably did not receive much fire because of sparse fuels, but the Mountain Laurel directly on the north-west side of the ridge received significant top-kill, especially where 10ft flame lengths were observed.
- The taxonomically difficult Georgia Aster (*Symphyotrichum georgianum*) occurs in the unit and no significant change was detected 1 year post.
- The Coneflower unit appeared to have burned in a much lighter manner and the effects seemed more desirable as observed 1 year post burn. Data collected were from 4 plots located in the Coneflower unit. No plots are located in the South Brushy unit.
- Fire spread was consistent throughout the unit and variability of the burn was scattered throughout the 2 units from moderate-high in some places and light in most of the two units

Table 1: Coneflower Fire Effects (n=4)

Burn Status	1000-hr Load	Duff Load	Litter Load	Total Load	% Overstory Mortality	% Pole Mortality
% Change After Third Burn	+8.48%	-15.84%	-96.21%	-33.69%	-15%	-83%

Fuels compared between 02yr05 and 03yrPost
Trees compared between 00PRE and 03yr01

The data shows, based on average from 4 plots, we are on our way to meeting the long-term objectives. The interesting event in this table is the increase in 1000 hour fuels. This indicates that in the dynamic system we live in progress is happening. Trees are being killed, falling down and becoming fuel or sitting around till they decompose and we continue to collect data. This is the most likely explanation of why we see an increase in 1000hr fuel loads. Other notes of excitement not reflected in the data are the lack of oak and pine seedlings and the lack of herb density. It is safe to say that this is a long term process and careful planning/burning will continue to help achieve objectives.

Aster Unit

This unit has encompassed what was formerly known as Mary Morris unit, Howser unit and the Aster unit. The Aster-Morris prescribed burn combined the Aster and Mary Morris burn units for a total of 289 acres. The Aster unit had previously all burned in April 2006, and parts of it (called Howser House) burned in 2002 and Oct. 2005. The Mary Morris unit is believed to have burned partially in 2001 and completely in 2003. The elevation in this unit ranges between 660' and 805'. The unit consists primarily of oak and mixed hardwood forests, with some pine scattered throughout. There are also a few grassy areas near the Mary Morris house. The SE

side of the Aster unit along the power line, which has a higher oak concentration along ridge-tops, appears to have burned hotter last time.

What the burn unit name implies is that a State species of concern for South Carolina is known to be present in this unit. Georgia Aster (*Symphotrichum georgianum*), whose historical range was in open Post oak (*Quercus stellata*) savannas, now is relegated to roadsides and Power-line right-of-ways. It is a fire-adapted species that is taxonomically challenging to say the least. Luckily for this species, its habitat was burned in this unit.

There was a significant amount of rain a couple days before the burn, so although the hardwood litter and fine fuels were dry, the duff and heavier fuels remained damp. The pine needles also apparently retained some moisture. Ignition of this unit was done by hand with two opposing Divisions using mostly flanking and backing fires. The Eastern half of the unit, fire carried well and consumed mostly litter as noted in Table 1. The western half of the unit has more shade and typically does not burn continuously throughout. The coverage of the burn is approximately 80-90%. For the most part, the areas residing in and around riparian did not burn. The overcast skies and careful ignition patterns helped this burn be a successful second entry burn.

Table 2: Aster unit Fire Effects (n=2)

Burn Status	1000-hr Load	Duff Load	Litter Load	Total Load	% Overstory Mortality	% Pole Mortality
% Change After Second Burn	-40.65%	-57.95%	-85.84%	-61.18%	-22.67%	-70.45%

All data compared between 00Pre and 04post/04yr01 reads

This data is based on the average of 2 plots that have been burned 4 times. Although there are not enough plots in this unit to speak confidently about the data, we are on our way to achieving those long-term objectives.

South Brushy(State Park)

This unit is located solely within the state park boundary. It was a cooperative effort made by KIMO staff. It is bordered by Piedmont road to the East, state park boundary to the south and west, and the South Brushy unit to the north. The topography of the unit is one that is dominated by one high point starting in the North and tapering off in all directions. The elevation ranges from 700-860ft.

The burn was executed perfectly in my opinion. The time of the test fire was 0800 and the burn was finished by 1100. Fire was brought down off the ridge-top in along 3 courses following the ridgeline. Fire backed to the boundary and roads and was only forced in compact litter areas that would not typically burn anyway. Litter was burned off the top and very modest duff reduction occurred if at all. All fire observed was backing or flanking fire with 1-3 ft. flame lengths.

IV. Long term Monitoring Results

Data from the long monitoring plots indicate that, while most objectives have not been achieved, the program is on course to achieve the desired levels of fuel reduction and pole-sized tree reduction early in the restoration period (Table 3). It is important to keep in mind that we are giving ourselves 4 burns of each burn unit to achieve these objectives, and that it is desirable to achieve them somewhat gradually. The apparent lack of progress in increasing pine and oak saplings and native herb cover are the same trends we see in nearly all of our plots, regardless of which park. The reason for this is that pine and oak regeneration and herb response can be considered lagging responses in the restoration cycle; that is to say that we don't expect them to improve until we further reduce the fuel loading and tree density.

Table 3. Results of long-term monitoring at King's Mountain NMP

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

V. Discussion and Comments

Fire-effects monitoring has been in place at KIMO for over ten years now, and much knowledge has been gained about the effects of prescribed burning on oak and pine forests in the Piedmont Monadnocks. Monitoring data has continually provided information that can be used to refine long-term objectives as well as prescriptions and tactics for individual burns. With this in mind, it is critical to also use monitoring data to examine individual burns and ensure that short term objectives and effects are supportive of the longer term goals. The brief analysis of the 2010 prescribed burns represents an attempt to use limited monitoring data and more extensive post-burn reconnaissance for this purpose.

With regard to long-term objectives, the park's prescribed fire program has been successful at reducing hazardous fuels and creating a range of structural and compositional effects across the landscape. The mean values for most of the objective variables in oak forests and woodlands indicate progress in a positive direction, while low overall values for oak regeneration and herbaceous cover illustrate the long-term challenges of restoring these communities. Viewing the pooled data from multiple burns, however, misses the important point that effects vary dramatically from burn to burn and even plot to plot. This underscores the need to examine fire effects at a range of scales and also to develop objectives for multiple time frames. We have attempted to provide objectives for long-term change as well as for individual burn events in the Goals and Objectives section above. We have also worked to develop *site-specific* information and objectives to support upcoming burns (see Section E of this document). We believe that these site-specific objectives provide a critical link to ensure that the effects of individual burns support the achievement of the long-term restoration goals.

C. 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
Planning	25%	FMP & EA work for GRSM, BLRI, MOCR, CARL. Section 7 consultation for GRSM. Development of site-specific objectives for FY11 burns. Many large and small things.
Presentations	5%	Oral presentations at FAM conference in San Antonio and to GRSM staff. Annual Report.
NPS Meetings/ task groups	2%	Strong involvement in GRSM Inventory and Monitoring workshops. Starfire workshop at GRSM.
Interagency work	5%	Steering team/Monitoring committee/DFC committee for Southern Blue Ridge FLN, Annual FLN Workshop.
Fire/Oil Spill Assignments	8%	Lots of prescribed fire throughout SER. READ assignment in Gulf.
Research	5%	Continued as Federal cooperator on regional JFSP dendrochronology project and Indiana bat project; various roles interacting with researchers.
Data Collection	15%	Some fieldwork at most parks. CBI work at GRSM. New program at BLRI.
Data management	2%	Various
Data analysis	15%	Estimated amount of time spent performing analyses, including data summaries and statistical tests.
Supervision/Admin	10%	Hiring, supervision, travel, payroll, crew support, purchasing etc.
Training	3%	Crew boss academy. OJT with saws.
Miscellaneous	5%	Mostly communication. Significant prep work on GRSM burn units.

Table 2. Fire Effects Crew Accomplishments/Focus Areas

Category	Percent Time	Notes
<i>FMH plots</i>	50%	Plot data collecting and preparing plot folders and equipment for field
<i>WUI plots</i>	0%	
<i>CBI plots</i>	5%	Crew assisted NATR in MACA and SHEN in GRSM with training CBI plots
<i>Other plot work</i>	0	
<i>Fire Assignments</i>	5%	• Assistant(ICT5) and 2 crew members worked on Calderwood Fire GRSM. 1 crew member also worked on ICT5 • Lead and assistant worked on Calderwood and Boogertown Fire in GRSM • Lead and Assistant worked on SER Helicopter detail
<i>Prescribed fire projects</i>	5%	Crew assisted with preparation and operations of prescribed fires in region
<i>Non-fire fuels projects</i>	5%	Lead detailed as READ to Gulf Oil Spill- Gulf Islands National Seashore
<i>Data entry</i>	20%	Completed data entry of all plot data for 2010
<i>Data analysis</i>	0%	Lead and Assistant worked on analysis for annual report
<i>Supervision/Admin</i>	3%	Lead monitor supervised crew of three most of season and maintained misc travel, time and purchasing paperwork
<i>Training</i>	7%	Lead training: L280, READ, SEDGE Assistant and 1 crew member attended ATV –“Train the trainer” program 1 crew member attended GPS for Wildland Fire workshop

D. Additional Information

Table 1. Data Entry and Projects Monitored

Park	% 2010 Data Entered	% 2010 Data Quality Checked	# Prescribed Fires Monitored*	# Non-fire Fuels Treatments Monitored*	# Wildfires Monitored*	# BAER Treatments Monitored*
Great Smoky Mountains National Park	100%	95%	6	0	2	0
Big South Fork National Recreation Area	100%	50%	2	0	0	0
Congaree National Park	100	50	3	0	0	0
Cowpens National Battlefield	100	100	0	0	0	0
Cumberland Gap Historic Park	100	50	3	0	0	0
Kings Mountain National Military Park	100	50	4	0	0	0
Blue Ridge Parkway	0	0	1	0	0	0
Moore's Creek National Battlefield	0	0	0	0	0	0

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

E. Site-Specific Monitoring and Prescribed Burn Objectives

The following pages provide examples of some of the site-specific products that our team has produced for upcoming prescribed burns. The goal is to provide durable products for more effective communication about individual units, which can vary widely in fuels, past fire effects, etc. Improved communication should help prevent negative outcomes.

We decided that the best way to do this was to provide site-specific resource and fuels information both spatially and with a *brief* written description (the pictures also seem like a good addition). The written briefing includes objectives that are tailored specifically for the individual burn, based upon existing conditions on the ground. The hope is that this information can be easily shared between transient burn personnel and park staff members, particularly during burn planning and day-of-burn briefings. Any feedback or suggestions for improvement are appreciated.

Note: The maps were difficult to incorporate into this document, and they are not displayed as well as I would like. This gives the reader the basic idea of what we've produced. You'll have to take my word for it that the actual maps that we're sharing with our colleagues look really good. I'm glad to send anyone a nicer version of any fire-effects products.

King's Mt. NMP: Objectives for North-Central Prescribed Burn – FY11

Goal: Restore and maintain vegetation structure and composition to accurately portray the landscape of 1780, when the battle of King's Mountain was fought. Secondly, restore and maintain fire and drought-adapted vegetation on dry sites.

Strategy: Use a series (3-5) of low to low-moderate severity prescribed burns to **gradually** reduce total fuel loading and **gradually** reduce woody stem densities in all strata; producing the variety of conditions that are favorable for regeneration of dry-site oaks (esp. chestnut & scarlet), shortleaf pine, native herbaceous species and low-growing shrubs. **Minimize initial mortality** of mature oaks and shortleaf pines and prevent growth release of fire-intolerant competition by utilizing low-intensity/low-severity fires early in the restoration process.

Note: This is our generic strategy for KIMO. With sections of this unit having already been burned a little too hot, we'll need to adapt this strategy to conditions on the ground at North-Central.

Site Information: The topography of the North-Central unit is predominantly rolling to hilly, with broad ridges and mild slopes; except for the southeastern portion of the unit, which is dominated by a very steep and rugged ridgeline. This will be the second entry of fire into North-Central. The western half was burned as "Swale" in 2006, and the eastern half was burned as "Midway" in 2007.

The vegetation and fuels throughout much of this unit are fairly typical of areas in the park that have received a single entry of prescribed fire; most of the fire effects are limited to the subcanopy, and a continuous (but thinner) layer of oak litter has re-formed since the initial burns. The goal for these areas will be to achieve a variable, low-intensity burn over a high percentage of the landscape. However, several ridgetops in the "Swale" unit and the entire southern half of the "Midway" unit received a very severe burn (dry conditions + head fires), which resulted in extensive canopy mortality. As in the Saddleback unit, this premature gap creation has diminished the local oak seed source and prompted a growth release of the shade-tolerant understory. The changes in structure and species in these gaps have altered the fuel bed from a continuous layer of fluffy oak litter (FM9) to a discontinuous layer of compact mixed-hardwood litter, which may impede fire spread and reduce intensity. The release of young sourwood, red maple and tulip poplar in these gaps has also allowed these less-desirable species to grow rapidly to a size that makes them difficult to control with the reduced fire activity.

As in Saddleback, the central challenge for this burn will be to generate enough fire intensity to control the hardwood regen, while moderating fire behavior enough to protect remaining mature oaks and pines.



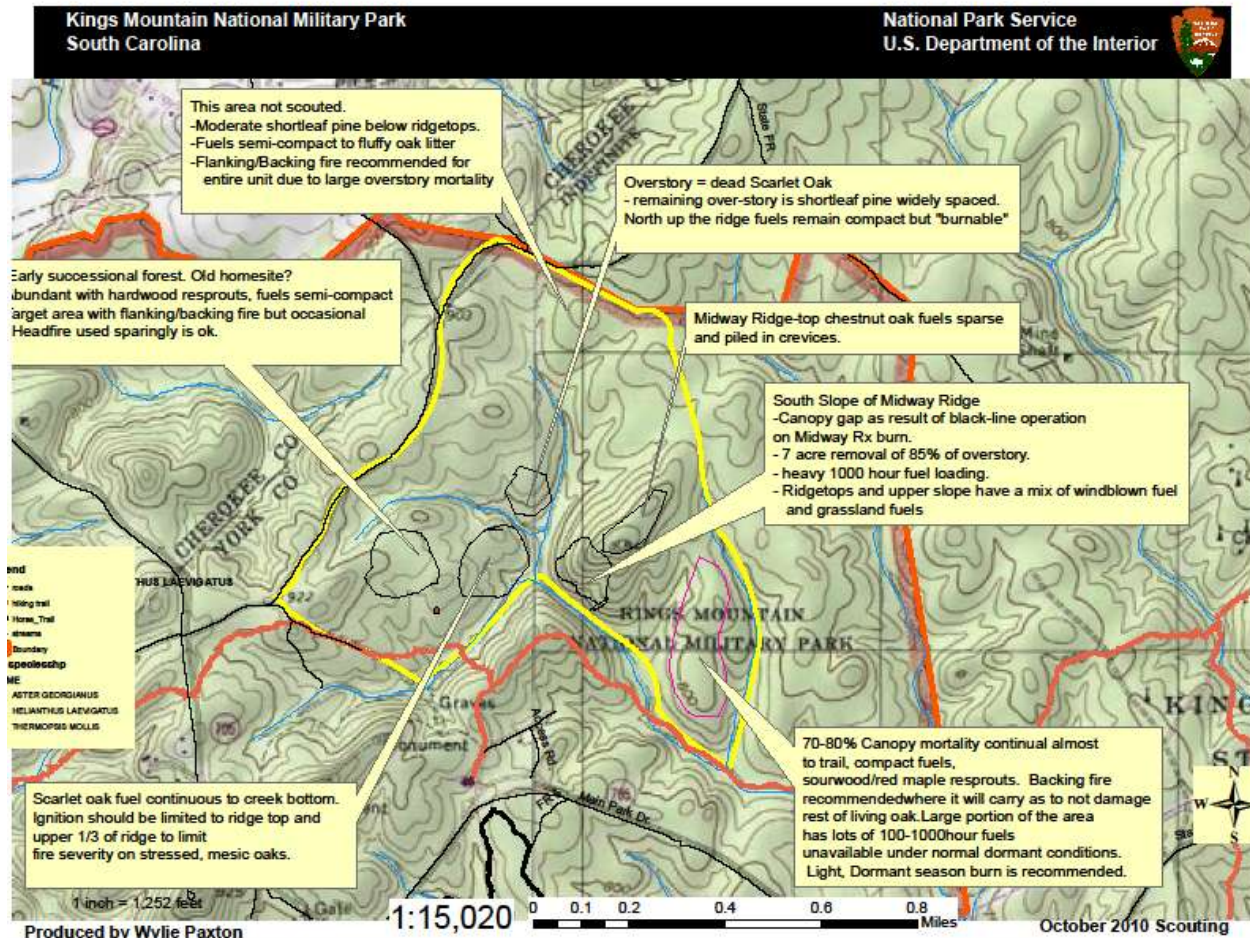
Photos: Extensive canopy mortality on the south end of 'Midway' –now part of North-Central. Note the sparse surface fuels and woody resprouts. Taken September 2010.

King's Mt. NMP: Objectives for North-Central Prescribed Burn – FY11

Specific objectives for the FY11 North-Central burn:

- **Consume >75% of surface litter** (fine fuels) over >70% of the area occupied by target vegetation. Target vegetation is typically oak and pine forests found on slopes and ridgetops, but also includes large areas of 5-10' tall hardwood regeneration with sparse overstory.
- **Use low-intensity backing fires** to protect mature oak and pine stands *and individuals*, **while utilizing a range of fire behaviors** to control (top-kill) non-oak hardwood regen.
- **Top-kill 30-60% of the midstory** (non-oak or pine) trees and shrubs as measured 1 year post burn. Again, this is for target areas described above.
- **Limit mortality of mature oaks to <10%** as measured 2 years post burn.
- **Prevent the creation of additional canopy gaps** in areas of mature forest by using low-intensity fire in these areas.
- Preferred timing is mid-February through March, 2011. Extra care needs to be taken to protect mature trees if burning occurs in late March or April.

King's Mt. NMP: Map for North-Central Prescribed Burn – FY11



Objectives for Lynn Hollow/Goldmine Prescribed Burn – FY11

Long-Term Goal: Restore and maintain fire and drought-adapted vegetation on xeric to dry-mesic sites.

Strategy: Use a series (3-5) of low to low-moderate severity prescribed burns to ***gradually*** reduce total fuel loading and ***gradually*** reduce woody stem densities in all strata; producing the variety of conditions that are favorable for regeneration of yellow pines (shortleaf, pitch, Table mountain), dry-site oaks (chestnut, scarlet, black, white), native herbaceous species and low-growing shrubs. ***Minimize initial mortality*** of mature yellow pines and oaks and prevent exotic plant invasions by utilizing low-intensity/low-severity fires early in the restoration process.

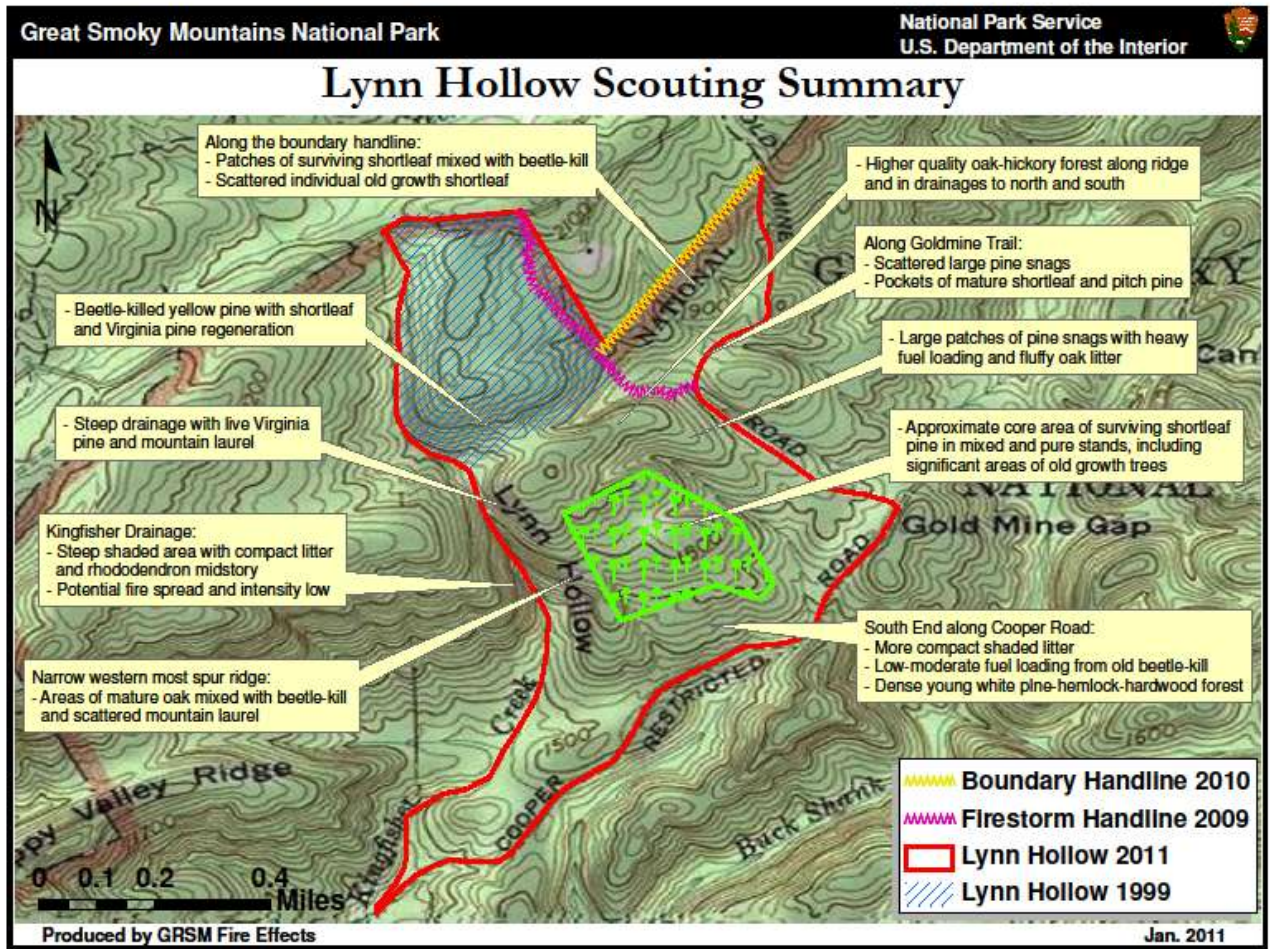
Site Specific: This part of the park is characterized by old shortleaf pine and oak forests that have a host of problems due mainly to fire suppression and exclusion. Even so, the old age and quality of the forest makes this a fairly unique area. The ongoing fire history study by the University of Tennessee has focused on the abundant fire scars from shortleaf pines in our burn area, and has found some of the oldest shortleaf pines known. Ongoing JFSP research on endangered Indiana bats and fire is also centered in this unit. The site has been recognized by numerous ecologists and managers as a place of unique value.

Part of the area was prescribed burned in June 1999, and there was a subsequent southern pine beetle infestation (2000-2002) that left very few of the large old pines alive. There is a fair amount of pine regeneration on the southern end of that '99 burn unit, and it will be desirable to maintain much of this regeneration. Today the entire unit contains examples of excellent quality oak forest, and a large patch of good quality shortleaf pine forest exists in the center of the "new" part of the unit. Fuels are typically hardwood litter, but concentrations of heavy pine fuels exist along the main ridgetop of the '99 burn area, along with the eastern side (Goldmine Trail), and to a lesser extent the southern side (Cooper Road) of the entire new unit. Live fuels such as mountain laurel and sapling white pine are found throughout the unit, but usually not at sufficient density to pose control problems. Heavy fuel loading coupled with mid- to low-slope perimeter lines indicate the need to manage any black-lining with care. A variety of firing techniques can and should be used while keeping the objectives in mind. The point is, we need to burn this area repeatedly and open it up, but we need to do it in such a way that we don't remove many of the existing mature oaks and pines or heavily impact the yellow pine regen – a tall order.

The following objectives should help guide the process:

- **Consume >75% of surface litter** (fine fuels) over >75% of the area occupied by target vegetation. Target vegetation is typically pine and oak forests found on south slopes, upper slopes and ridgetops.
- Fire Intensities should not exceed the following spatial proportions:
 - <5% high intensity (FL >8')
 - 5-20% moderate intensity (FL 3-8')
 - **75-90% low intensity (FL 1-3')**
- Burn should be conducted with appropriate fuel conditions (i.e. KBDI) to achieve **15-35% total fuel reduction** (the largest part of the fuel bed is duff that needs to be reduced gradually). KBDI 35-100 (typical of late winter/early spring) will typically produce this result on a first entry burn at GRSM. KBDI on first entry burns should usually not exceed 200. The higher the KBDI, the less intensity is desired.
- **Top-kill 30-60% of the midstory** (non-yellow pine) trees and shrubs as measured 1 year post burn. Again, this is for target areas of dry oak and pine.
- **Limit mortality of mature yellow pines and large oaks to <20%** as measured 2 years post burn.
- **Prevent the creation of large canopy gaps** (>.5 acre) in areas of mature forest.
- Preferred timing is March through the first week of April, 2011.

Map for Lynn Hollow/Goldmine Prescribed Burn – FY11



Cumberland Gap NHP: Objectives for Hensley A & B Prescribed Burn – FY11

Long-Term Goals: Reduce hazardous fuels around historic structures and along the park boundary. Secondly, restore and maintain fire and drought-adapted vegetation on the drier sites.

Note: The goal in younger, successional forests is to reduce woody stem density where appropriate (drier areas) and encourage the growth of species that are best suited to individual sites.

Strategy: Use a series (3-5) of low to low-moderate severity prescribed burns to **gradually** reduce total fuel loading and **gradually** reduce woody stem densities in all strata; in effect reducing the risk of high-intensity fires threatening historic structures or private property. It is expected that this approach will also produce the variety of conditions that are favorable for regeneration and growth of dry-site oaks (chestnut, white, and red), native herbaceous species, and low-growing shrubs. **Minimize initial mortality** of mature oaks and prevent exotic plant invasions by utilizing low-intensity/low-severity fires early in the restoration process.

Site Information: Hensley Settlement A and B are a combined 325-acre prescribed burn area along the park's northern boundary. Both are part of the Hensley Settlement historic site, which contains numerous historic structures and a cultural landscape of large open fields. The vegetation in the units is dominated by forests of varying age classes, though Unit B has a large section of open field. The B unit wasn't scouted, but the park's vegetation map indicates that the unit contains large areas of successional (young) Virginia pine and red maple forest interspersed with older forests of chestnut oak/hickory. A swamp forest/bog complex is mapped where Shillalah Creek intersects the Indian Rock Trail on the western end of the B unit. This should be scouted prior to the burn, and fire should not be forced into this area.

Unit A appears to contain large areas of successional birch and maple forest interspersed with mature chestnut oak and red oak forests on the ridges and upper slopes. A mature hemlock forest with a thick rhododendron understory occurs along Martin's Fork in the east end of A. Again, it is not desirable to force any fire into this area.

Overall, these units contain a younger, more mesophytic mix of forest types than we usually burn at CUGA. In fact, much of the area will be characterized by thin, compact litter that may not carry fire well. Most importantly, we need to utilize low intensity fires in the areas that do contain mature oak forest with heavier fuel loads.

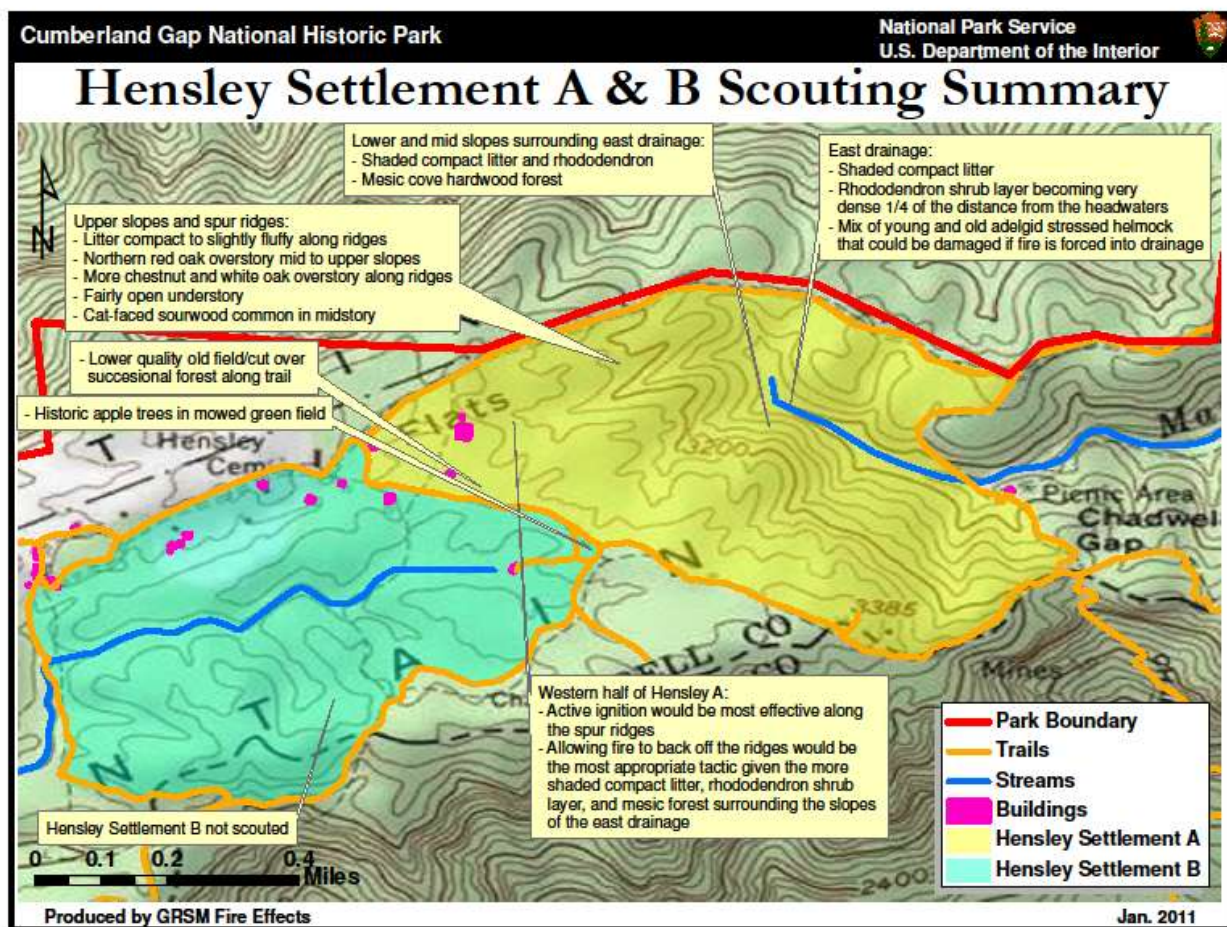


Photo: Oak forest typical of upper slopes at Hensley

Objectives for Hensley Settlement A & B - 2011:

- Consume >75% of surface litter (fine fuels) over >75% of the area occupied by target vegetation. Target vegetation is mature dry oak forests found on ridges and upper slopes.
- Consume >60% of surface litter in areas of younger successional forest that are conducive to fire spread
- Burn the unit with primarily low-intensity backing fires
- Reduce total fuel loading in target areas by 20-40%
- Top-kill 20-40% of the midstory (non-oak) trees and shrubs. This is for target areas of mature oak forest and younger successional forests.
- Limit mortality of mature oaks to <10%.
- Prevent the creation of large canopy gaps by using low-intensity fire.
- Preferred timing is March through the first week of April, 2011.

Cumberland Gap NHP: Map for Hensley A & B Prescribed Burn – FY11



The End