



Southern Appalachian/Piedmont Fire Effects Monitoring Team

***Fire Effects/Fire Ecology Annual Report
Calendar Year 2011***



Pictures (clockwise from top left)

***Cleistes bifaria* (small spreading pogonia orchid)– from a Pitch pine monitoring plot on Arbutus Ridge at Great Smoky Mountains National Park.**

Prescribed fire is used to help control encroachment of Liquidambar styraciflua (sweetgum) in native-grass meadows of Cades Cove in Great Smoky Mountains National Park.

***Stenanthium gramineum* (eastern featherbells) – two populations were observed flowering in a twice-burned oak-hickory woodland at Bald Knob, Big South Fork National River and Recreation Area.**

***Seedlings of Pinus palustris* (longleaf pine) at various stages of growth in the RCW site at Congaree National Park. This longleaf stand has been burned 10 times since 1984, and is scheduled for burning in spring 2012.**

***A partially-restored Schizachyrium scoparium* (little bluestem) glade in the Saddleback burn unit at King's Mountain National Military Park. This grassy glade is part of a globally rare (G2/G3) chestnut oak – blackjack oak woodland that is found at several locations at KIMO. This area has been burned three times in the past 12 years.**

***Arundinaria gigantea* (giant river cane) – has been observed flowering in Cades Cove (GRSM) following prescribed burns. A related species was observed flowering at Cowpens National Battlefield.**

A. Summary

The Southern Appalachian/Piedmont fire effects/fire ecology team provided support for eleven NPS units in the Southeast Region during 2011, in addition to supporting a busy wildfire season in the South and the ongoing Gulf Oil Spill cleanup. Aside from a substantial number of plot visits to our network parks (**Table 1**), the team worked with the Natchez Trace and Shenandoah crews to complete high priority plot-work outside our network and outside the region. As in years past, we also contributed to monitoring efforts across agency boundaries, working with US Forest Service fire managers to help achieve regional monitoring goals of the Southern Blue Ridge Fire Learning Network.

Table 1. Fire Effects Plot Workload 2011

Park	Monitoring Type	Type of Plot	Pre-burn 2011	Immed. Post 2011	Postburn (1-20 yrs) 2011	Annual Total 2011	Total Plots
Big South Fork (BISO)	Little Bluestem	FMH Forest	0	0	1	1	4
	Shortleaf Pine	FMH Forest	0	0	0	0	2
	White Oak	FMH Forest	2	4	5	11	13
Cumberland Gap (CUGA)	Scarlet Oak	FMH Forest	0	0	5	5	16
Congaree Swamp (COSW)	Longleaf Pine	FMH Forest	0	0	0	0	5
	Loblolly Pine	FMH Forest	0	0	2	2	5
Great Smoky Mountains (GRSM)	Scarlet Oak	FMH Forest	0	0	6	6	15
	Black Oak	FMH Forest	0	0	0	0	4
	Yellow Pine	FMH Forest	0	0	11	11	35
Kings Mountain (KIMO)	Blackjack Oak	FMH Forest	0	3	5	8	8
	Chestnut Oak	FMH Forest	0	8	17	25	21
Cowpens (COWP)	Southern Red Oak	FMH Forest plot	0	0	0	0	2
Blue Ridge Parkway (BLRI)	Chestnut Oak	FMH Forest	2	0	0	2	2
Moores Creek Battlefield (MOCR)	Coastal Plain grassland	Photo Point	0	0	0	0	1
Cherokee National Forest	High Elevation Oak	Modified FMH Forest	0	0	0	0	3
Pisgah National Forest	Pine-oak-heath	Modified FMH Forest	0	0	2	2	2
Total			4	15	54	73	138

Though wind and smoke concerns resulted in a tough year for completing prescribed burns in our part of the region, the crew participated in the completion of at least 11 prescribed burns, including a significant false start and the eventual burning of the 2000-acre Bald Knob unit at Big South Fork NRR. Other 2011 prescribed fire highlights included another successful fall burning campaign in Cades Cove (GRSM), and the reintroduction of fire into the Saddleback unit at King's Mountain NMP.

The fire effects team roster remained stable for 2011, and all crew members continued to provide operational support for local and national incidents (**Table 2**). Aside from the highlights listed in Table 2, each team member contributed to the management of an interesting fire season at our home park. Far and away the most interesting fire event of the year was the Beard Cane Gap wildfire that started from a lightning strike on July 25, and lasted until September 6. This fire occurred within a very remote area that had been prescribed-burned in spring 2008, and quickly moved onto Short Mountain, which was part of a large swath that was severely impacted by the historic tornado outbreak of April 27, 2011. Extremely difficult to access, this fire was managed for resource objectives, and achieved a final size of 316 acres. More details about this fascinating event, and about the tremendous impacts of the tornado on the long-term fire effects monitoring program in the Smokies, can be found in the GRSM section of this report.

Table 2. Fire Effects/Fire Ecology Staffing 2010

Staff	Starting Date	Ending Date	# of Pay Periods	READ Qualified (Yes or No)	Training and Development
Rob Klein Fire Ecologist	1/1/11	12/31/11	26	Yes	Peer-reviewed publication of GRSM fire effects data. IC5 taskbook completed; FIRB taskbook started; 14-day assignment to BICY and Okeefenokee with CUGA WFM
Wylie Paxton Lead Monitor	1/1/11	12/31/11	26	Yes	14-day wildfire assignments to FL/GA and TX; attended Fire in Oaks Conference
Matthew Wood Assistant Lead Monitor	1/1/11	12/31/11	26	No	14-day wildfire assignment to TX; Father of new baby girl (Elizabeth Kate Wood)
Bob Dellinger Crewmember	3/11	11/11	18	Yes	READ assignment for Gulf Oil Spill (45 days); Eastern Fire Ecology Summit at SHEN
Huma Alvarado Crewmember	3/11	11/11	18	Yes	READ Training; 14-day assignment to BICY and Okeefenokee with CUGA WFM; Eastern Fire Ecology Summit at SHEN

Additional Fire Ecology/Fire Effects program highlights from CY 2011 include:

- Publication of data and analysis from long term fire effects monitoring at GRSM in the peer-reviewed journal “*Forest Ecology and Management*.” A summary can be found in the GRSM section of this report.
- Assisting with training courses at the Advanced Academy in Chattanooga (RX-310, Fire Effects Monitoring and FFI)
- Assisting North Carolina State Parks with a Burn Boss training course, providing NPS experiences with fire effects and adaptive management in the mountains
- Mentoring several volunteers, students, and past coworkers in the areas of fire effects, fire ecology, fire management, and NPS resource management
- Participating in an NPS “Eastern Fire Ecology Summit” at Shenandoah NP, where we installed plots and talked about how to share information and resources between the NE and SE Regions of NPS

- Implementing site-specific qualitative monitoring (in addition to normal plot work). Both the values and the shortcomings of this approach were noted and those ideas are being incorporated into future plans.
- Making major progress in incorporating fire effects monitoring into the adaptive management process in our network parks; particularly GRSM, KIMO, and CONG
- Remaining very active in ongoing research efforts and in promoting new research by helping to develop ideas and providing letters of support
- Continuing to develop a strong regional fire ecology community through participation in the Southern Blue Ridge Fire Learning Network. Our parks are members of three separate landscapes within the FLN, and our team members provide steering committee membership, monitoring committee membership, and on-the-ground expertise in fire effects monitoring.
- Adding two parks to our active fire ecology network: Ninety-Six National Historic Site in central South Carolina and Cape Hatteras National Seashore in coastal North Carolina.

Research Update

In last year's report, we discussed several funding sources for fire-related research and tried to begin a dialogue about developing a standing list of research questions to address the knowledge gaps at each park. In this year's report, we want to reiterate our desire to work with the parks to develop research needs and ideas, so we have that information on hand when money becomes available or when we talk to students/researchers who are looking for project ideas. Research needs or questions about funding should be directed the fire ecologist (rob_klein@nps.gov). The following are updates on either ongoing or upcoming research projects, grouped by funding source.

Joint Fire Science Program (JFSP):

Our team continues to be involved in two research projects funded by the JFSP, and both with broad applicability across the Southern Appalachians. The funding period for our ***Southern Appalachian fire history study*** has ended, and we are anxiously awaiting the final products from that study, which will include several publications and two doctoral dissertations. Both dissertations will utilize extensive fire scar data from GRSM.

The other JFSP project is an ongoing study to determine ***the relationship between fire and the ecology of endangered Indiana bats in the Southern Appalachians***. This is a critical study, because of the potential conflicts between best management practices for the bats and fuels management operations. So far this study has revealed that these bats are active during the spring and summer months in the parts of the GRSM landscape that have the most fire history, and that they are preferentially selecting pine snags as roost trees. Other interesting highlights include the discovery of maternity colonies in areas that have been prescribed burned within the past 4-6 years. The lead researchers of this study have submitted a proposal to JFSP to conduct further research on bat ecology and the interactions with fire.

NPS Fuels-Reserve Research Fund:

The NPS Fuels-funded ***project to map pre-settlement vegetation and fire regimes at BISO*** hit a serious contracting snag in 2011, but thanks to the efforts of Southeast Region Fire Ecologist Caroline Noble, is back on track and expected to begin in 2012. This is an exciting project that will bring in Dr. Cecil Frost, a foremost expert in fire ecology, to apply his unique modeling skills to the Cumberland Plateau landscape. This type of work is extremely valuable in helping to guide prescribed fire restoration efforts, and we would certainly like to see work like this done for several of the parks in our network. Anyone interested in submitting a proposal for such a project should contact Rob Klein or Caroline Noble.

NPS Combined Call:

Another recently-funded study that will be of great interest to those involved in fire management and fire-effects monitoring is a project that will ***characterize the avian communities and habitat of the heavily fire-impacted southwest corner of GRSM***. This study will be funded in part through the NPS Combined Call and the final product is expected to be an M.S. Thesis that can help inform fire management at GRSM, though some of the results will be useful across a wide geographic range. The Supervisory Forester at GRSM is the research coordinator for this project, and our fire-effects team hopes to be closely involved with the development and field work.

NPS GIS Data Development Project Fund:

Finally, though it is not research *per se*, the Southeast Region fire program has submitted a proposal to fund a GIS intern for a year, to provide Fuels Management support to a group of NPS units. The intern would be based at GRSM and supervised by the network Fire Ecologist (Rob Klein). The primary intent of such a position would be to ***create accurate maps of Prescribed Fire and Fuels projects that are up to current NPS Standards***. It is expected that a year-long internship would also aid tremendously in the ***development of our remotely-sensed burn severity data (dNBR)***. For those of you unfamiliar with burn severity mapping, these are maps of prescribed or wild fires that indicate severity (low, medium, high) at a 30-meter pixel resolution. These maps are a tremendous resource in recording and monitoring the short and long term effects of a given fire, and have great potential for a variety of future research. The last we heard on this proposal was that it tied for first in funding consideration (nationally), and that funds are pending the final budget formulation.

Again, 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. *"Chance favors the prepared mind."* - Louis Pasteur

B. Management Objectives and Monitoring Results 2011

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 2011 prescribed burns
- analysis of long-term fire-effects monitoring data
- a summary of major fire effects findings to date.

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

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

Big South Fork National River and Recreation Area (BISO): 2011 Fire Effects Monitoring Annual Report

I. Overview

The monitoring crew completed all scheduled plot visits in 2011, and completed all data collection except for herbaceous layer sampling at one plot in Bald Knob, due to hazardous snags. Most of the field work over the past year centered on pre- and post-burn monitoring of the expanded Bald Knob burn unit, and some additional work was done at Darrow Ridge, which was prescribed-burned for the second time during spring 2010. Two new plots were installed in 2011, both in the previously unburned section of Bald Knob. Due to uncertainty surrounding the completion of this project, these plots were not installed until right before the burn (during the dormant season, and hence no baseline herbaceous-layer data were collected. Additional work included qualitative surveys of numerous portions of the Bald Knob burn unit.

The fire ecologist made four visits to BISO during 2011, which included trips to conduct pre-burn field work, plan the Bald Knob prescribed burn, attend an FMP-rewrite meeting, and conduct post-burn monitoring of Bald Knob. Ecology work this year focused on developing appropriate Bald Knob-specific objectives/prescription and communicating that information to burn practitioners. This is part of a continuing effort to ensure that each burn unit receives burn treatments that take into account site-specific factors such as vegetation/fuel condition, past fire effects, and unique features. Other work included development and testing of a qualitative protocol to augment the quantitative plot data during planning and post-burn evaluation. This protocol entails completing a 1-page descriptive field form, collection of relevant GPS data, and taking geo-referenced photos. These data were extremely useful in preparing the Bald Knob prescribed burn review found in section III, below.

II. Program Goals and Objectives

The following goals and objectives constitute the general aims of the BISO prescribed fire program. There are also 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 emphasize that these objectives (especially the single-burn objectives) may need to be adapted or otherwise changed to meet the needs of a particular burn. The process of adapting burn objectives 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 on every burn, 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 of 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% should burn in high intensity (FL >8')
 - 5-20% should burn in moderate intensity (FL 3-8')
 - 75-90% should burn in 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. Review of 2011 Projects

Bald Knob (2,080 acres):

The Bald Knob prescribed burn was conducted on April 7, 2011. This burn was a continuation and enlargement from a 2006 prescribed burn, also called Bald Knob (**see Figures 1 and 2 for comparison**). The original project area was burned on April 13, 2006 as a 680-acre block, with the dual goals of reducing hazard to homes along the park boundary and restoring fire-adapted vegetation. The hazard to park neighbors was realized after the busy fire season of 2000, when one of the largest wildfires in the recent history of the NRRRA, the Schoolhouse fire, severely burned over 2200 acres directly adjacent to the small community at Bald Knob.

The Bald Knob area was also discussed in Julian Campbell's "Ecological Rationale for Fire...of the NRRRA" as a priority for restoration with prescribed fire. Along with (formerly) large stands of shortleaf pine, populations of several fire-benefitted herbaceous species and several herb-rich sandstone glades were cited as reasons for reintroducing fire to this section of the park. The dominant vegetation type at Bald Knob, particularly in the "new" portion of the burn unit, is dry oak forest consisting of scarlet oak, white oak, black oak, and chestnut oak, with little oak regeneration. Mixed hardwoods and conifers occupy stream-sides and sheltered lower slopes, while several large expanses of native-grass fields can be found within the project area.

Since Campbell completed his work (2001), shortleaf pine stands at Bald Knob, and throughout the park, were decimated by southern pine beetle attacks. Dry weather, aggressive ignition and the open conditions and heavy fuels associated with extensive pine-beetle kill all contributed to a relatively large area of moderate to high severity following the 2006 burn (**Figure 1**). Indeed, one of the long-term monitoring plots (QUAL02) was situated adjacent to a pine-beetle-kill patch, and experienced 20-30% overstory tree mortality following that initial burn. Also as a result of the 2006 burn, areas within the beetle-kill patches experienced high mortality of residual overstory trees and a staggering release of native hardwood resprouts (most notably red maple) which resulted in the formation of a dense coppice along ridges and upper slopes.

The objective of the second entry of fire at Bald Knob (2011) was to continue the long-term process of reducing hazardous fuels and restoring fire-adapted vegetation, but to limit the intensity and severity of the fire to help achieve those long-term goals *while minimizing mortality of remaining overstory trees*. In the case of the previously unburned ("new") section of the unit, the objective was likewise to conduct a low intensity/low severity burn to initiate the restoration process *with minimal mortality of mature oaks*.

Remote sensing of the burn severity following the 2011 prescribed burn (**Figure 2**) provides evidence that the primary objective of conducting a low-severity burn was achieved in both the original Bald Knob unit as well as the new section. Overstory and pole tree data from long-term monitoring plots (**Table 1**) support the notion that this was primarily a low severity burn, as do numerous observations taken during repeated, extensive surveys of the burned area. Interestingly, comparable values for fuel reduction between the two burns (see **Table 1**) suggest that differences in fire effects on trees were perhaps due to differences in intensity (e.g. the 2006 burn had more head fires) or post-fire drought conditions.

Figure 1. Extended assessment burn severity for Bald Knob Rx – 2006.
The section west of Laurel Crossing Branch was not included in the 2006 burn.

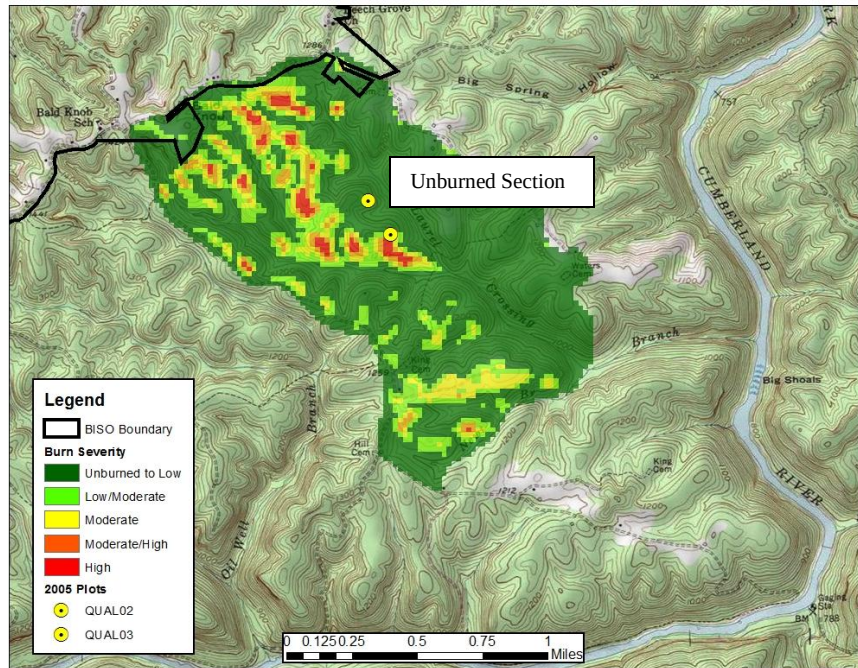


Figure 2. Extended assessment burn severity for Bald Knob Rx – 2011.
The southwest corner was not included in the 2011 burn.

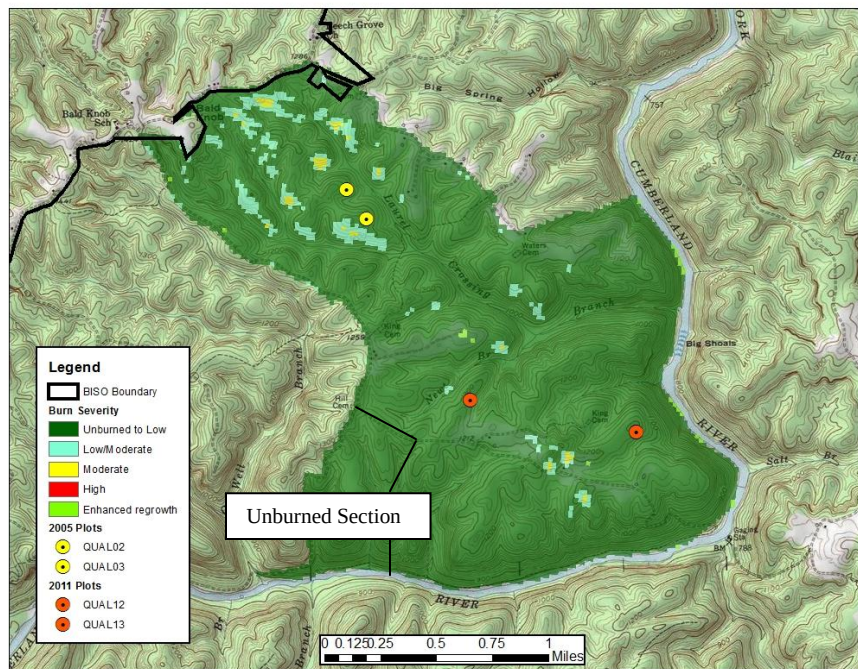


Table1. Fire Effects at Bald Knob: 2006 vs, 2011. (n=2 for each year)

	Severity*	Litter Change	Duff Change	Woody Fuel Change	Total Fuel Change	Pole Trees	Overstory Trees
2006	2.4	-94%	-4%	-51%	-49%	-89%	-12% (-34% after 2 burns)
2011	3.1	-99%	-35%	-25%	-57%	-52%	-3%

*Severity is rated for 40 points in each plot and averaged. Scale of 1-4, 2 = moderate, 3 = light.

Note – Based on field surveys, these plots seem to be reasonable representations of fire effects in dry oak forests of the Bald Knob landscape for these burns. These data are not representative of pine-beetle-kill sites or other vegetation types.

A great deal can be learned about fire management at BISO, and in the Appalachians in general, by a close study of the Bald Knob prescribed burns of 2006 and 2011. In the interest of brevity, some of the most important information is presented below as bullet points, followed by a couple of recommendations for future fire management at Bald Knob.

Fuels

- Examination of the north boundary that is adjacent to private property and homes reveals that these two burns have not been particularly effective at reducing the heavy fuel loading hazard (downed trees and logs)
- Given that heavy fuels are typically too moist to burn in early spring, it is no surprise that these fuels experienced very limited consumption
- Following southern pine beetle and a hot initial burn, many pine snags have fallen to the ground, contributing to what is probably a net gain of heavy fuel loading across the unit since 2005
- The good news is that this heavy fuel loading may finally begin to decline without additional large inputs
- It would not be desirable, either from a fire control standpoint or ecologically, for all of the heavy fuels to be consumed in a single fire event across any landscape
- Other good news is that the hazard from live fuel loading (esp. Mt. Laurel) along the north boundary has been somewhat reduced by fire operations, though this shrub will resprout and grow back.

Vegetation

- Throughout very large portions of the original Bald Knob (2006) burn unit, extremely open conditions and repeated top-kill of understory hardwoods has resulted in a tremendous growth release of hardwood sprouts which will require frequent burning to control (principal spp. – red maple, black gum, big-leaf magnolia, tulip poplar, sourwood)
- These areas also have a moderate abundance/moderate diversity of sun-loving herbs, as well as a tremendous abundance of low-bush blueberry and blackberry
- There are few living pines remaining and very limited pine regeneration is occurring at this time. Oak sprouts are present, but are still vastly outnumbered by other hardwoods

- Oak forests in the original burn area are very interesting, with very open understories, greater diversity of herbs, and greater flower/fruit production than one typically finds in comparable unburned forests at BISO
- During field surveys, two populations of eastern featherbells (*Stenanthium gramineum*) were documented flowering in this open oak woodland habitat – we’re unsure about the status of this plant, but this was a very nice find
- Forests in the “new” portion are more oak-dominated, and mostly experienced a light but solid understory burn that should be very complementary to achieving long term objectives – much of the newly burned area still has a bit too much shading to have realized any substantial increase in herb diversity
- The 2011 burn generally did not spread into the more mesic vegetation and fuels of the lower slopes and drainages
- The open portions and much of the edge of the large fields appeared to have burned well, which should result in good reduction of woody stem encroachment in these areas

Recommendations

- Conduct some focused fuel reduction along the boundaries that are adjacent to homes at Bald Knob - pile burning will almost certainly be necessary
- Continue prescribed burning – could divide the unit up if total size is a factor
- To maintain the gains from the first two burns, the north end will need to be burned within 2-3 years; the south end could wait an additional 1-2 years
- After fuels are reduced along the boundary, strongly consider a low-intensity growing season burn of the north section – avoiding severe drought conditions (note: this approach will require great care, but is essential to providing better consumption of heavy fuels and better control of hardwood resprouts)
- An agreement with landowners to burn off of private property has potential to improve the effectiveness and safety of protection efforts along that boundary.

IV. Long term Monitoring Results

Data from two new plots in Bald Knob were added to the analysis in 2011, and the results have been updated to reflect the increase in sample size. 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 vegetation responses are to be expected; we are essentially using fire to gradually create suitable habitat for oak regeneration and native herbs which should increase as habitat is created. 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. Our plots were stratified to represent fire effects in dry oak forests as a whole, and are not fully representative of areas within and adjacent to patches of southern-

pine-beetle-kill where overstory mortality has been highest. 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.

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) <i>14 plots</i> <i>*2 new plots added in 2011</i>	>50% Reduction in total fuel loading	Total fuel reduction After one burn = 52% ($\pm 2\%$) (<i>n=10 plots</i>)	Yes, but will require more time to assess.	2012
	>70% Reduction in pole-sized tree density ($\leq 15\text{cm dbh}$)	Pole reduction After one burn = 58% ($\pm 7\%$) (<i>n=10 plots</i>)	Not yet, but on course.	2012
	20-40% Reduction in overstory tree density ($> 15\text{cm dbh}$)	Overstory reduction After one burn = 4% ($\pm 2\%$) (<i>n=11 plots</i>)	Not yet, but this is a long-term objective	2012
	>200 tall ($> 1\text{m}$) Oak seedlings /ac	Preburn mean: 96/acre (± 43) Post-burn mean: 103/acre (± 35) (<i>n=11 plots</i>)	Not after a single burn.	2012
	>30% Cover by native herbs	After 1 burn: 14% (± 5) (<i>n=11 plots</i>)	Not after a single burn.	2012
Little Bluestem Sandstone Glade/Savanna (FSCSC1) <i>3 plots</i>	>70% Reduction in pole-sized tree density	Pole reduction: After one burn = 16% ($\pm 11\%$) After two burns = 30% ($\pm 14\%$) (<i>n=3 plots</i>)	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= 3 plots</i>)	Yes, but not with 80% confidence	2011

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

No new data were added to the fire effects analysis for Sandstone Glades in 2011, so there are no updates to the table from last year. 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 appear 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.

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, most notably in the dry oak forest type. Management of extremely high fuel loads and vegetation changes associated with southern-pine-beetle activity remain difficult challenges. Additional qualitative monitoring is now being used to assess the fire effects in these areas. Safety remains a paramount concern for working in these habitats, and the qualitative approach seems to balance the need for information with exposure pretty well. The review of the Bald Knob prescribed burn of 2011 utilizes data from remote sensing, long term monitoring plots and such qualitative surveys to provide insights into a range of fire effects on vegetation and fuels that have broad applicability for the BISO resource management program, and other oak/pine restoration efforts in the east.

An important theme for the BISO fire program continues to be adaptive management. The burn of Bald Knob in 2011 adds another success story to the BISO prescribed fire program, but there is still a great deal of work to do. 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): 2011 Fire Effects Monitoring Annual Report

I. Overview

There was little fire effects work done on the Parkway in 2011. Despite an impressive build-up, the prescribed burn at Haw Creek was called off due to gusty winds. No additional work was needed on the monitoring plots in that unit, and those plots will be re-read if the burn is completed in FY12. Several trips were made to the Parkway in 2011, to assess future burn units with the Cumberland Gap Wildland Fire Module and to conduct preburn scouting of two large Forest Service burn units (Singecat and Lost Bear West) that will include Parkway lands. Additionally, members of the NPS fire effects team assisted USFS personnel to complete long-term monitoring plots in the Lost Bear East burn site. Information gathered during the 2011 site visits contributed directly to very productive meetings with interagency partners early in 2012. This interagency collaboration has been greatly enhanced by the Southern Blue Ridge Fire Learning Network, and has in turn given the Parkway some options for getting prescribed fire on the ground without having to build a large fire organization.

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% should burn in high intensity (FL >8')
 - 5-20% should burn in moderate intensity (FL 3-8')
 - 75-90% should burn in 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. 2011 Projects

There were no prescribed burns completed in 2011. Haw Creek was canceled and rescheduled for FY12.

IV. Long term Monitoring Results (*repeated from last year's report*)

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): 2011 Fire Effects Monitoring Annual Report

I. Overview

Despite an organizational build-up and an ideal daytime weather window (April 14), the much-needed re-burn of the RCW burn unit was canceled due to concerns about poor night-time smoke dispersion. As a result there was little fire effects monitoring done at Congaree in 2011, though the fire ecology staff made several site visits to participate in discussions with resource managers about the past and future of the prescribed fire program at the park. The monitoring crew did complete all scheduled plot visits in 2011, which amounted to re-reads of two plots in the Red Bluff unit. No new plots were installed in 2011, however the fire effects team continued to develop a qualitative monitoring protocol to augment the quantitative plot data during planning and post-burn evaluation. This protocol entails completing a 1-page descriptive field form, collection of relevant GPS data, and taking geo-referenced photos. In addition, the team continued to work with park staff to develop a spatial dataset for isolated occurrences of longleaf pine trees and seedlings.

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. 2011 Projects

No prescribed burn projects were completed in 2011.

IV. Long term Monitoring Results (largely repeated from last year's report)

The monitoring results for CONG have not been updated for this report. The most recent addition to the dataset are 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 of the Red Bluff burn in last year's annual report provided a summary of the new information that exists from the CONG monitoring program.

As discussed in previous annual reports, the 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% (+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

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. Such a walk also reveals a tremendous amount of hardwood sprouting in the understory, the most abundant species of which is sweetgum (*Liquidambar styraciflua*). It has become clear that the burn rotation of the past 8 years has not been successful at controlling sweetgum; in fact, it is likely that the last solid burn of the RCW site was March 3, 2006 (See **Table 2**).

Table 2. Prescribed burning of the RCW site.

Date	Acres Burned	Notes
March 24, 1984	80	Prior to monitoring program
March 28, 1985	78	Prior to monitoring program
February 12, 1992	142	Prior to monitoring program
April 19, 1995	193	Prior to monitoring program
April 8, 1999	300	Full extent unknown
April 27, 2001	300?	Full extent unknown
May 16, 2002	575 (units 1-4)	Full extent unknown
April 29, 2004	575 (units 1-4)	Not a complete burn
March 3, 2006	575 (units 1-4)	Full extent unknown
November 29, 2008	575 (units 1-4)	Incomplete, cool burn

This current fire regime seems to have favored the formation of a thick coppice of 5-10' tall sweetgum in the understory of large portions of the RCW burn unit, with slightly less density and height in parts of the unit that burned well in October 2008. Recognition of this tremendous increase in sweetgum (and to a lesser extent wax myrtle) has led to plans for:

- increasing the frequency of burning of the RCW site
- targeting that area for early growing season burns (specifically mid to late April)
- utilizing intensive ignition strategies to ensure a complete burn of the pine forest.

Research evidence points to the need for vigilance to eliminate sweetgum once it has become established in the understory. Waldrop and others (GTR SE-45) found that 8 years of annual summer burns were required before high levels of sweetgum mortality was achieved. However, Sparks and others (1999) suggest that moderate-intensity burns during the late dormant season or early growing season (March-April-May) can also be effective for control of hardwoods when summer burning is not possible. This latter observation seems to hold true for longleaf stands at Congaree when one considers the relative success of the burning program prior to 2006. Monitoring will be necessary to determine the dynamics of sweetgum under various burning scenarios that may unfold in the future.

A final item of concern that has been observed during monitoring surveys of the RCW site is the fire-related damage to hardwood trees in the narrow band of unique vegetation that occupies the Bluff. In particular, multiple beech (*Fagus grandifolia*) trees in the RCW area have significant cat faces, possibly from ill-timed ignition from the base of the bluff during one of the many prescribed burns of this area. The trees have survived, and most are in good condition; however, any future *intensive burning* of the Bluff itself could result in fire burning into these cat faces and causing more severe damage or mortality. Most of these trees will be fine as long as low-intensity fires are allowed to *back* into the Bluff and begin to burn themselves out along the swamp edge. This is something that needs to be identified during the planning sessions for burns at Congaree, and incorporated into ignition plans.

Cowpens National Battlefield (COWP): 2011 Fire Effects Monitoring Annual Report

I. Overview

From a fire effects monitoring standpoint, there is very little new information to report for Cowpens. A single prescribed burn (Loop Unit #'s 5 and 6) was completed in 2011, but this area contains no long-term monitoring plots. The fire effects crew did complete a qualitative post-burn survey for this unit, and the findings are summarized in Section III, below.

In October, the fire ecologist attended a meeting with the new Superintendent of Cowpens (John Slaughter) and members of the Cumberland Gap Wildland Fire Module to discuss the prescribed fire program. These discussions indicated a change in the direction of the fire program that will have a major impact on fire effects monitoring at the Battlefield. The Battlefield wishes to continue burning the fields and woodlands within the Tour Loop Road, but will discontinue burning along the park perimeter.

The goals of the revised prescribed fire program are to: 1) Restore the open conditions of the original battlefield scene, and 2) to retain a vegetative buffer between the central battlefield and the surrounding highways, as recommended by the Cultural Landscape Report. This change will affect the burn units known as Hayes, West Side, and East Side. As Hayes and West Side were the only two locations of long-term fire effects monitoring plots, the monitoring approach for COWP will need to be reevaluated. The fate of any hardware (rebar, tree tags) in those existing plots will await further consultation with Battlefield staff.

II. Program Goals and Objectives

Goals – COWP is using prescribed fire to manage grasslands and forests inside the Loop Road. 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 of woodlands adjacent to the battlefield.

Burn Objectives -- Objectives may need to be adjusted after further discussions with Battlefield staff and members of the Wildland Fire Module, but the following may still be relevant:

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.

III. 2011 Prescribed Burns

Loop Project Units 5 and 6 (160 acres):

Units 5 and 6 comprise the southern “half” of the Loop Project, and these areas have been burned in the past under the names “Scruggs” and “Battlefield.” For most of this area, this was the second entry of fire in the past five years. The vegetation of this area ranges from old fields with woody encroachment to old brushy tree-lines to forest patches. Populations of the Federally Threatened plant *Hexastylis naniflora* occur along two unnamed streams within this burned area. In accordance with the current Biological Opinion, no specific protective measures were taken with respect to these populations. The objectives very generally include reducing fuel loads and reducing woody encroachment into fields.

The burn was conducted on February 15, 2011 by members of the CUGA and GRSM modules. Very dry and breezy conditions combined with tall flashy fuels (old fields) to generate significant intensity and high levels of fuel consumption. Post-fire surveys were completed by the fire effects crew after green-up to assess the impacts of the burn on vegetation. These surveys revealed a burn that achieved the structural objectives for open fields, but probably exceeded desired severity in some of the forest patches. Char heights of 1-2 meters (3-6’) were commonly observed on mature oaks and even tulip poplars along the southeastern unnamed stream. While no large patches of killed overstory were documented, char heights of 1-2 meters are frequently associated with damage that can make large trees more susceptible to extended droughts or repeated burning. Most of the higher intensity seemed to have occurred in the east, east/central and north parts of the unit.

Casual survey of known *Hexastylis* habitat (streamside/stream terrace) revealed a patchy burn that left individuals closest to the stream edge unburned. Other individual plants were observed to be re-growing in patches where the fire had burned. No counts were conducted, but the general assessment was a neutral effect. A related concern that will need to be monitored during future visits was the rapid recolonization of some streamside areas by Japanese honeysuckle. Though not clearly related to burning, this species poses a threat to populations of *Hexastylis*.

One final note about these burn units relates to the presence of another invasive exotic plant; sericea *Lepedeza*. This brushy species has been observed within the Loop Project area since prescribed burning and fire effects monitoring began several years ago, and was undoubtedly around long before that. Sericea *Lepedeza* is known to respond well to fire and can be very invasive in degraded fields and open woodlands. This species was observed to be: a) very abundant within this burned area, b) on the increase, and c) spreading into woodland edges. There may be an opportunity for the Exotic Plant Team to help develop additional strategies for managing this species.

IV. Long term Monitoring Results

There is not much to say about long-term monitoring at COWP at this time. There were no additional data collected during 2011, and the existing data come from plots that will be discontinued. The program will need to be re-evaluated and re-directed to answer questions that pertain to the current strategy.

V. Discussion and Comments

Fire effects monitoring at COWP will be undergoing a transition over the coming year, as we try to determine the best way to provide resource information to the park's managers and fire practitioners. It's likely that the monitoring strategy will include:

- Highly mobile, qualitative surveys with photopoints and gps data
- Qualitative and quantitative surveys of *Hexastylis* populations that occur in burned areas
- Mapping of exotics.

Cumberland Gap National Historic Park (CUGA): 2011 Fire Effects Monitoring Annual Report

I. Overview

The monitoring crew completed all scheduled plot visits at CUGA for calendar year 2011, and conducted extensive surveys of Sugar Run B (which has no plots), Hoot Owl Hollow, and to a lesser extent, Dark Ridge C. This qualitative protocol entails completing a 1-page descriptive field form, collection of relevant GPS data, and taking geo-referenced photos. There are often multiple field forms for each survey event, and the surveys have proven invaluable for augmenting the plot data during planning and post-burn evaluation. These data were extremely useful in preparing the Sugar Run B prescribed burn review that can be found in section III, below.

The fire ecologist was able to make several visits to CUGA during 2011, which included trips to work on smoke modeling with the module, help lead the Sugar Run B prescribed burn, conduct plot reads at Dark Ridge C and Hoot Owl Hollow, and conduct extensive field surveys of recent burns. In the coming year, we hope to provide support for planning and implementing the forthcoming revision of the 5-year prescribed burn schedule, and develop a better partnership with park staff to manage exotic plant encroachment into burned areas.

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% should burn in high intensity (FL >8')
 - 5-20% should burn in moderate intensity (FL 3-8')
 - 75-90% should burn in 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. 2011 Prescribed Burns

Sugar Run B (43 acres):

Sugar Run B was burned for the second time on March 21, 2011. The unit was burned for the first time in late winter of 2008, when it generally received a mild burn. The site is comprised mostly of steep slopes and a small amount of low-elevation ridgetop. The vegetation ranges from dry oak forest to a more mesic mixed-hardwood forest on the lower slopes, with pockets of beetle-killed pine scattered on mid- to upper slopes. Fuels are mainly hardwood litter, but concentrations of heavy pine fuels exist along the ridgetops, especially the east end of the ridge that runs along the park boundary.

Ignition during the 2011 burn started relatively late in the day, at almost 1600, and weather conditions were mild (high temp 75, low rh 44%). Ignition was along the ridgetops, with narrow strips and dots used to work the fire down the slope. Due to the deliberate ignition strategy, most of the unit burned in backing fires and short-duration, low-intensity headfires. Fuel consumption was generally good, with nearly complete litter removal on upper slopes and deep charring of large rotten logs. Fire spread diminished on lower parts of the slope, resulting in a patchy burn with only about half the litter consumed.

A thorough survey of the site was conducted during the 2011 growing season, which revealed very nice fire effects. Fuel reduction was excellent for this second-entry burn, though a large amount of heavy pine fuel remain throughout the site. Mature oak and pine trees were minimally impacted, while competing hardwoods of all size classes have sustained damage, which should ensure reductions in their numbers following additional burns. In particular, the saplings of beech, red maple, sourwood and blackgum have been greatly reduced, leading to very open understory conditions, abundant oak seedling growth, and increasing abundance of low shrubs and herbaceous species. In nearly every way, this site is in ideal condition following just two prescribed burns, and it is a good model for success in reintroducing fire. However, as with many sites at the Gap, invasive exotic species are present and are likely increasing with the fire disturbance. In Sugar Run B, the exotic threat is *Microstegium vimineum*. This species was associated with the old unimproved road that forms the west boundary of this unit, and was already present in and around the NW corner of the unit even before the initial prescribed burn. It does appear to have increased with the opening of the understory in this area, but still makes up a small percentage of the area within this burn unit.

IV. Long term Monitoring Results

There were not significant enough additions to the dataset in 2011 to warrant re-analyzing the objective variables, so this section has been repeated from last year's report. 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 continues to operate 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 this is largely associated with 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 prescribe cooler conditions for first- and second-entry burns. Slight increases in *Microstegium* in Sugar Run B illustrates an exotic species moving into an area that has been only lightly burned, though this species has simply expanded from large unmanaged populations along the unimproved road ("College" road?). In a larger sense, the success at Sugar Run B described in section III of this report offers a model for implementing prescribed burns at the Gap, and holds out a great deal of promise for timely restoration of a declining oak-woodland ecosystem.

Great Smoky Mountains National Park (GRSM): 2011 Fire Effects Monitoring Annual Report

I. Overview

2011 was an eventful year for fire-effects monitoring at GRSM. Despite not completing the Lynn Hollow prescribed burn, the crew had a busy year of managing wildfires, monitoring long-term plots at the Stony, Arbutus, and Wash Ridge burn units, and prescribed burning in Cades Cove. There were several interesting wildfires, and an unprecedented series of severe weather events highlighted by an EF3 tornado that left a 12 mile-long path through the park's western end. The tornado will have a lasting impact on the fire-effects monitoring program at GRSM, and this is discussed in *Section III* of this report, along with reviews of the Beard Cane Gap wildfire and the Cades Cove prescribed burning program.

The monitoring crew made visits to all of the scheduled plots in 2011, but was unable to complete all of the plot reads due to safety concerns about overhead hazards resulting from fire effects and extreme wind damage. Eight of the thirteen scheduled reads were completed, and a qualitative assessment was completed for the other five. Tornado impacts, and growing concerns about full-day exposure in hazardous, fire-impacted plots, points to a need to re-examine the existing monitoring protocol and explore other options, a difficult process that will occur over the coming year.

In fire ecology, 2011 finally saw the publication of important fire effects data from GRSM in a peer-reviewed international journal, *Forest Ecology and Management*. The publication of monitoring data in a strongly research-oriented journal is a significant step in helping to build the credibility of NPS monitoring as a component of scientific knowledge in fire ecology. An abstract and full citation of the paper is included in *Section IV* of this report.

Goals for the coming year include: 1) complete all scheduled reads of existing plots while providing for safety first, 2) develop and test 1-2 options for a supplementary monitoring protocol, 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, and 4) conduct monitoring surveys of burned areas in Cades Cove and develop a map that depicts the worst areas of woody encroachment or other resource concerns.

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% should burn in high intensity (FL >8')
 - 5-20% should burn in moderate intensity (FL 3-8')
 - 75-90% should burn in 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

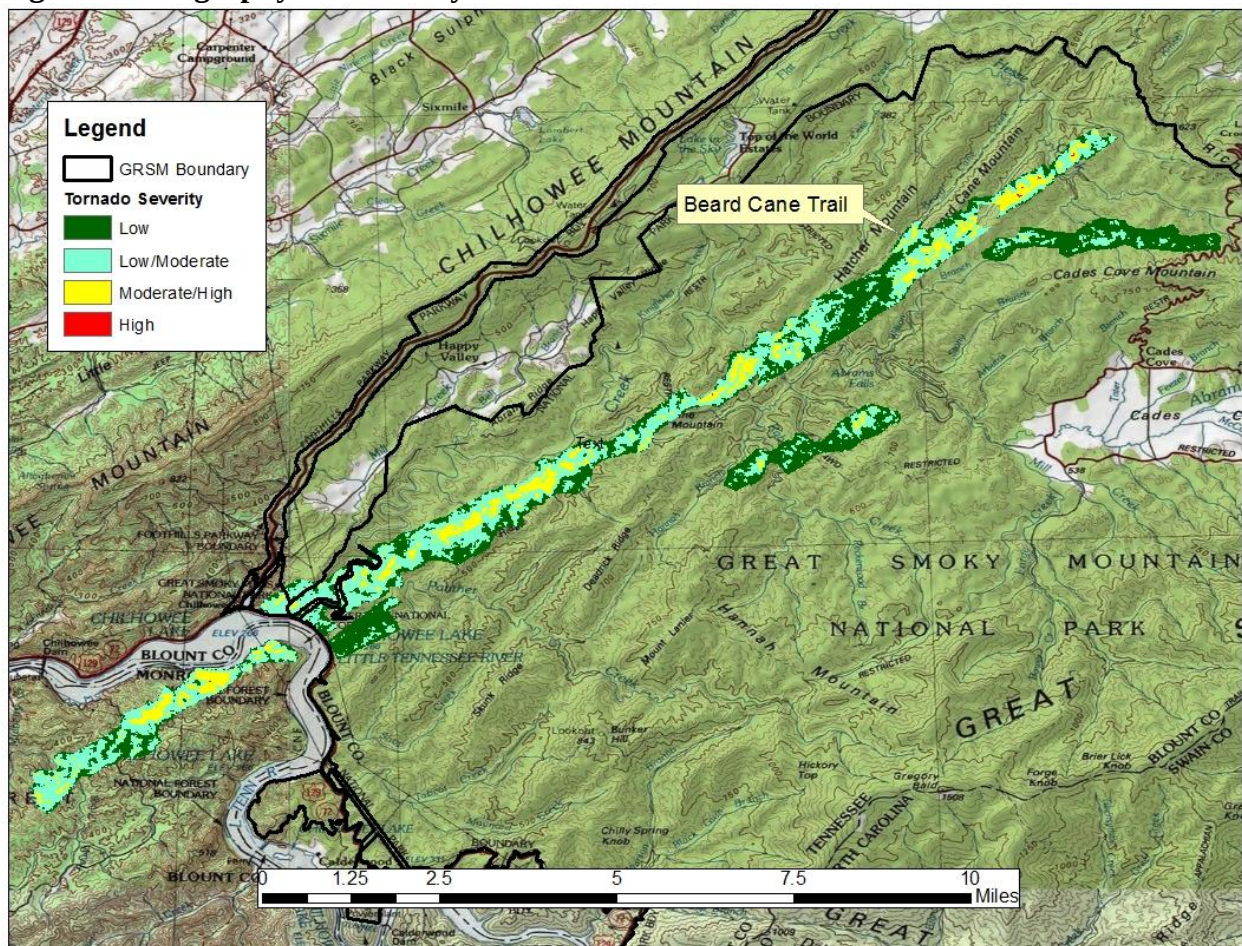
Please see Table 2 below for more information on objectives and long-term monitoring data. Note that the objectives above are a bit of a hybrid from our separate oak and pine types.

III. 2011 Prescribed Burns and Disturbance Events

Tornado and Extreme Wind Events of Early Spring, 2011

At least two significant weather events impacted the western end of GRSM during the late winter/early spring of 2011. On March 23, a powerful storm system produced a tornado in Greenback, TN just 20 miles due west of the park. When it reached the park, this storm produced very strong straight line winds known as mountain waves, which can reach surface speeds of nearly 100 mph. It is still not clear how much of the park was impacted by mountain waves, but initial assessments placed the most extensive and severe impacts in the vicinity of the Beard Cane Trail (Figure 1).

Figure 1. Geography and severity of 2011 weather events.



Nearly a month later, on April 27, the park was impacted by an EF3 tornado during a historic tornado outbreak that occurred throughout the southeast. The path of the tornado and its relative severity were mapped by a USGS analyst at the EROS Data Center using remote-sensing techniques that were developed for mapping fire severity (**Figure 1**). The methods, in brief, use Landsat 7 satellite imagery taken before and after a given disturbance event during times of comparable phenology. The difference in reflectance at pre-defined wavelengths then produces a value (known as dNBR – differenced normalized burn ratio) that can be classified using known thresholds. The images for this analysis were taken during the growing season, and pixel scale is 30m x 30m.

It should be noted that using fire severity methods to map tornado effects has no basis in published science, and that full interpretation of these data require extensive ground-truthing and regression modeling. With that said, limited on-the-ground surveys combined with knowledge of effects for different fire severity classes suggest these *possible* severity class descriptions:

- **Green pixels** – limited or no impacts to forest canopy; damage may include broken limbs or single-tree/small-group tree fall
- **Blue pixels** – moderate impacts to forest canopy with limited impact to midstory; this may range from heavy upper limb removal to multiple-overstory tree tip-up or snapped trunks
- **Yellow pixels** – moderate to high impacts to forest canopy with some impact to midstory; damage may include large pockets of heavy overstory tip-up or snapped trunks with varying levels of damage to the midstory canopy
- **Red pixels** – high levels of impact to overstory and midstory trees; similar to yellow pixels, but these isolated areas may have had very little midstory or understory cover prior to the tornado

Aside from being “once-in-a-lifetime” disturbance events, these weather phenomena had a tremendous impact on both the prescribed fire program and fire effects monitoring program at GRSM. **Figure 2** shows the primary tornado path as mapped using dNBR methods. Hatcher Mt. and Beard Cane are the two burn units that sustained the most extensive wind and tornado damage, though significant wind-related damage was encountered in nearly every plot in the Stony Ridge and Arbutus Ridge burn units as well. This clearly demonstrates that the combined effects of this year’s wind events extend well beyond the primary tornado track. Plots to the west of the tornado track were either not assessed (Hatcher Mt.) or not impacted (Lynn Hollow). The impacts to the prescribed fire and monitoring programs can be summarized as:

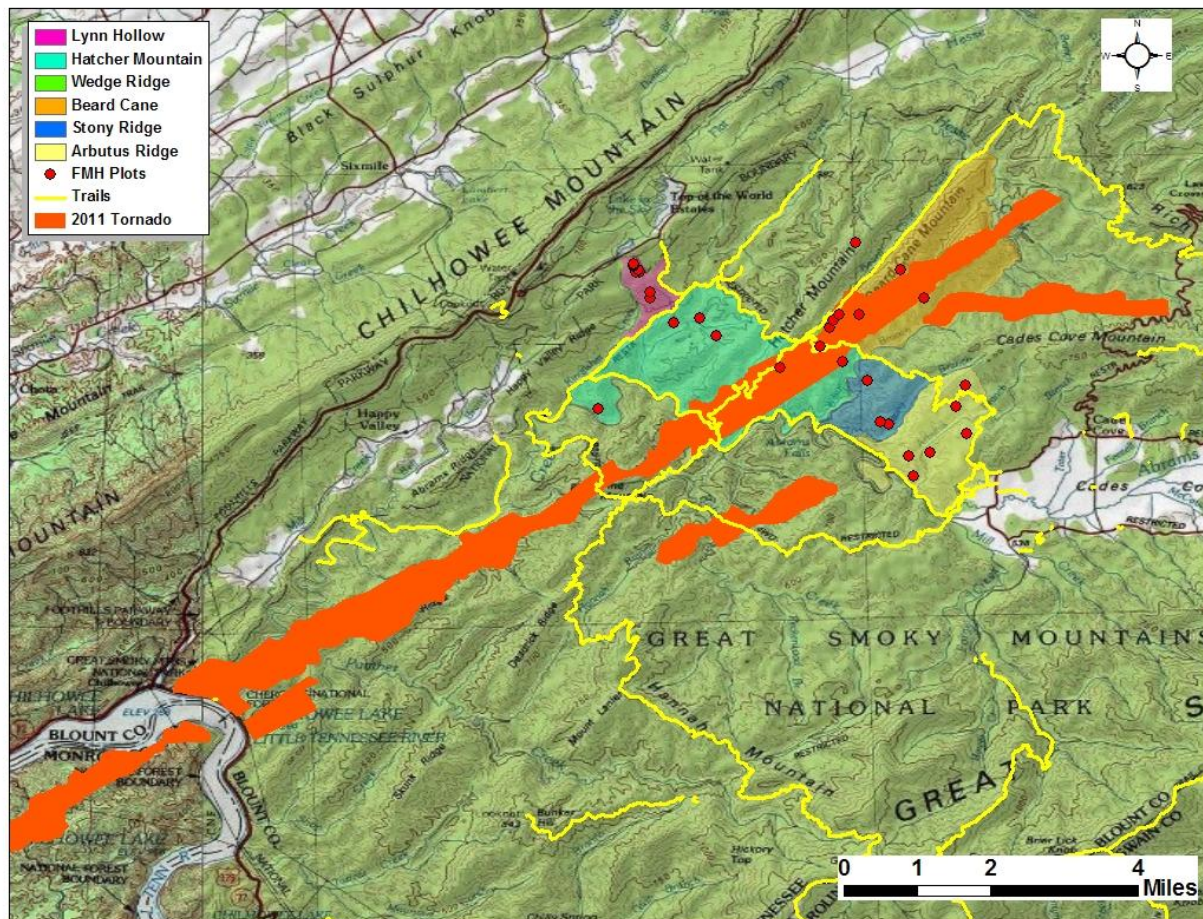
Major Impacts to the Prescribed Fire Program

- Massive storm damage on Cooper Road and Beard Cane Trail is still not fully cleared; these trails were critical holding lines for these large burns and will need to be cleared before the areas can be re-burned. Re-burning these sites on a frequent basis is critical to long-term fuel reduction and ecological restoration
- Extensive overstory mortality and damage have increased fuel loads that were already quite large; this will limit when burning can occur, because we will need to avoid burning under conditions when too much consumption would occur. Too much consumption could negatively impact remaining overstory trees or cause damage to soils

Major Impacts to the Fire Effects Monitoring Program

- 9 plots (17% of fire effects plots) were directly in the path of the tornado and likely sustained serious damage; these plots are now either too difficult to travel to or too dangerous to work in
- Many other plots not directly in the tornado path were impacted to varying degrees by winds, contributing to hazards that already existed in those plots
- These plots are the primary means by which the park monitors the effects of prescribed burning; with the program so heavily impacted, alternative methods may need to be used to monitor the long-term effects of fire.

Figure 2. Tornado/wind impacts to GRSM Fire program.



In addition to these impacts, there will be an increased risk of very severe wildfires in the coming years. It is well known that the western-most portion of the park is drier and more fire-prone than anywhere else in the park. This area has a relatively high occurrence of wildfire, both human- and lightning-caused. The Beard Cane Gap wildfire, which is discussed below, is a clear reminder that we can easily get a wildfire along the 12-mile path of this tornado. As the tornado-downed tree trunks and tops begin to cure over the next 1-2 years and become available as wildland fuel, there is a high probability that any wildfires that occur in this area will be very severe and difficult to control, especially during a pronounced drought. Prescribed burning during cool conditions may be one way to reduce the risk of high severity fires, but the amount of tornado damage that can be treated is limited.

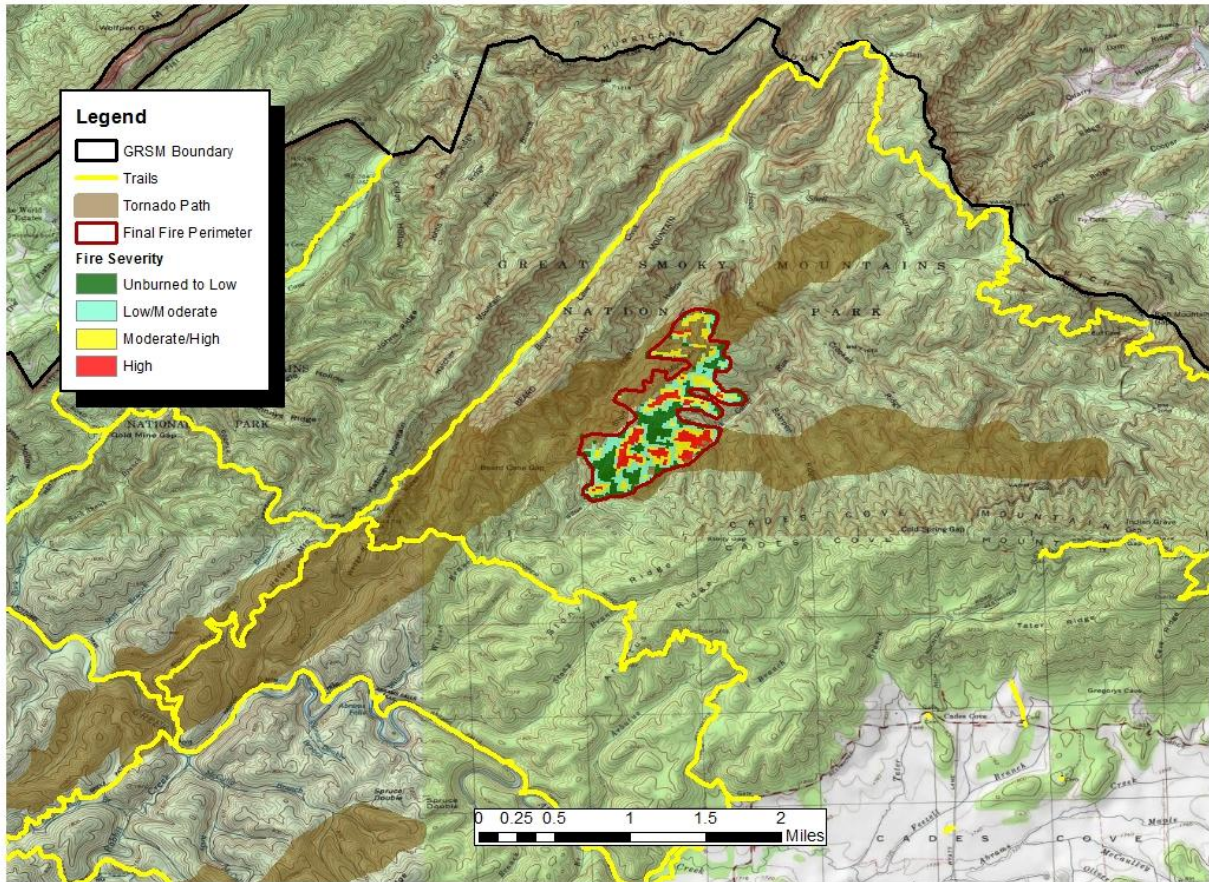
Beard Cane Gap Wildfire (316 acres)

The following bullets were part of an informational packet developed for park staff while the burn was ongoing. They provide a good outline of the events of this fire. More ecological information will be available after the monitoring crew is able to conduct field surveys in the upcoming year.

- The Beard Cane Gap wildfire was ignited by lightning on July 25 in the park's western end
- The fire was reported on August 2, but early attempts to locate the fire on foot were hampered by heavy tornado damage and the remote location of the fire
- Initial *estimates* put the location of the fire near Beard Cane Mountain
- Between Aug 3 and Aug 11, the fire received approximately 1-2 inches of rain, and smoke was only observed sporadically until Aug 16, when more consistent smoke allowed a US Forest Service helicopter to give a more accurate fire location and size-up
- The fire was mapped by GRSM Fire Management staff on Aug 17, and the location was confirmed as Short Mountain, which is adjacent to the larger Beard Cane Mt. – fire size at that time was 15 acres
- The fire burned exclusively on Short Mt., which was the site of a controlled burn in spring 2008, and which was also heavily impacted by extreme wind events of early 2011, most notably the tornado(s) of April 27
- The fire primarily burned in pine and oak litter and twigs on ridge-tops and slopes where the forest canopy has been opened up by tornado blow-down, southern pine beetle, and past burning
- The downed timber resulting from the tornado was generally not consumed because it hadn't had sufficient time to dry out, though heavy fuels from older disturbances experienced greater consumption
- The strategy was to confine the fire to Short Mt. and Beard Cane Mt., allowing fire to burn in those areas to achieve resource management goals, which include allowing naturally occurring fires to reduce forest fuels and help maintain the park's natural diversity
- Between 9/4 and 9/6, the fire area received approximately 6 inches of rainfall, which effectively extinguished the fire

- After the fire was declared out, remote sensing (dNBR) was requested from USGS, which resulted in a very clear footprint and an image of a relatively high severity fire (**Figure 3**)
- Interestingly, though the tornado damage facilitated the spread and persistence of this fire, the severity appears to be at least as much a function of previous disturbances, most notably southern-pine-beetle attacks and prescribed burning.

Figure 3. Final footprint and severity of the Beard Cane Gap wildfire (316 acres)



Cades Cove Prescribed Burning

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 open 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 initiated in the fall of 2009, so this was the third season for fall burning. Fields and approximate acres burned in 2011 can be found in **Table 1**. **Figure 1** provides general locations for areas burned. During the 2011 burns, woodlots were excluded from burning to mitigate impacts to Indiana bat habitat.

Table 1. Cades Cove burns, November 2011. Acreages may vary.

Field Name	Size (acres)
Tipton Oliver	200
Primitive Baptist Church	200
Cable House	90
Old Field*	20
Upper Tater Branch	44
Pumphouse Marsh	13

* Only the upper portion of Old Field was completed

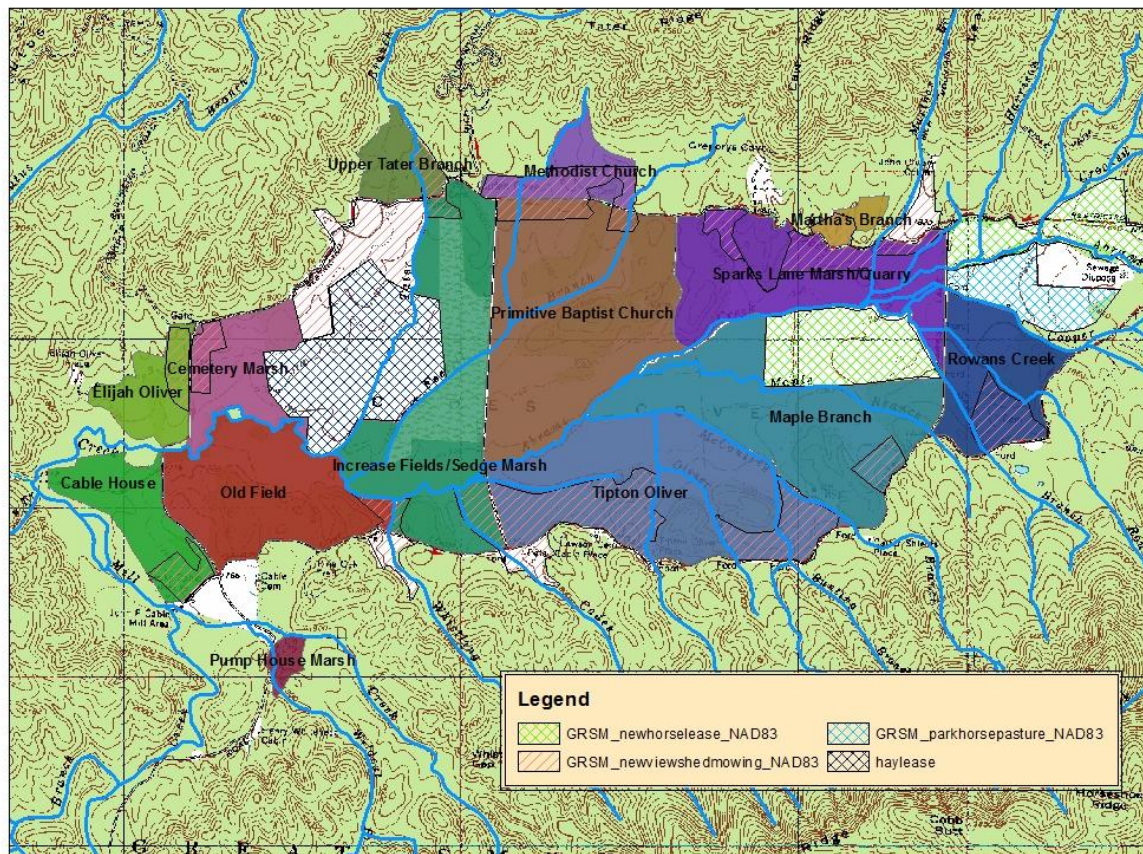
The Primitive Baptist Church unit generally burned in a uniform and continuous manner throughout the main portion of the field, even through several areas of thick blackberry (*Rubus* sp.) encroachment. However, along the eastern boundary, the unit has several narrow fingers of field surrounded by forest that burned in a very patchy manner due to longer periods of shading throughout the day and fuels composition that included more of a live, moist tall fescue (*Schedonorus arundinaceus*) component and less of the cured native grasses, such as panic grass (*Panicum anceps*), broom sedge (*Andropogon virginicus*), Indian grass (*Sorghastrum nutans*), and purpletop (*Tridens flavus*), which typically drive the spread of fire in these fields. These moist, sheltered areas have high densities of young woody encroachment (esp. *Acer negundo*) that will not be effectively controlled by the patchy burning.

Tipton Oliver was a carry-over from the previous year that was able to be incorporated into this year's rotation despite the size of the unit and an already heavy work load. This unit was somewhat uniform in fuel composition with a few areas of moderate to heavy blackberry encroachment and a notable area of yellow-poplar (*Liriodendron tulipifera*) encroachment in the eastern corner of the unit. Fire spread was fairly continuous, likely top-killing most of the woody resprouts.

Cable House was broken into two subunits and burned on separate days, with the north subunit located between Abrams Creek and the Abrams Falls trailhead access road, and the south subunit located south of the Abrams Falls trailhead access road and adjacent to the Cades Cove visitor center area. The north subunit was a continuous burn throughout the main field and was partially allowed to burn into the edge of riparian forest along Abrams Creek where most of the targeted

woody encroachment was located including an area with heavy sweetgum (*Liquidambar styraciflua*) growth, and moderate pitch pine (*Pinus rigida*) and Virginia pine (*Pinus virginiana*) growth. This encroachment likely experienced only low to moderate severity effects with very few stems being top-killed due to stem size and spacing and due to the fire being suppressed before it had time to move through the entire area. The southern subunit also burned in a fairly continuous manner and contained several areas of heavy blackberry encroachment in the main field and heavy sweetgum encroachment along the forest edge on the west boundary. The blackberry was top-killed in most areas of the field, but the sweetgum experienced varied impacts depending on size of stem and composition of surrounding fuels. However, more stems of sweetgum than usual were top-killed during this rotation. This was due to a combination of more favorable weather conditions compared to previous burns and a more pointed effort to target these areas by moving the west boundary line into the woodline allowing fire to move completely through the sweetgum encroachment area and into the adjacent forest where it abruptly went out in the moist and compact leaf litter.

Figure 1. General locations of Cades Cove prescribed burn units.



The Old Field unit was only partially burned during this rotation due to time constraints and the potential need for some mechanical thinning. Therefore, only the west portion of the unit adjacent to the Cades Cove loop road was burned, while Old Field proper was excluded. The west subunit of Old Field burned fairly intensely through the core of the field and along the west edge, while the east edge had more shading and slower spread. The north end burned slightly

less intense and more patchy due to moisture and composition of fuels (more fescue) and proximity to the Abrams Creek riparian corridor. Woody encroachment, which included blackberry and sweetgum, was likely top-killed throughout the burned area. In the excluded main area of the Old Field, however, sweetgum has become established in significant size and number of stems since the last burn and will continue to be a major concern, especially given the greater ecological value of this field compared to many of the other field units with less species diversity and a heavier disturbance history. The plan is to burn this section in the spring to maximize the impact to sweetgum.

Upper Tater Branch is a hillside field unit with moderate to heavy blackberry encroachment spread throughout the field and pitch pine encroachment coming into the field from the forest edge on the uphill side of the field. Due to time of day and overall time constraints this unit was burned in a ring fire pattern starting along the woodline across the uphill side then working down the hill and across the bottom along Tater Branch, resulting in a fast moving and moderate to high intensity fire. Most of the blackberry was likely top-killed as well as some of the smaller stems of pitch pine that were scattered further interior into the field away from the dense encroachment along the forest edge.

The Pumphouse Marsh unit is a small marsh area that was originally an open area with some scattered shrubs, but over the years it has become choked with blackberry, eastern white pine (*Pinus strobus*), and mixed hardwood encroachment. There has been interest in burning this unit for several years due to the historic presence of certain plants of interest, including a yellow-eyed grass (*Xyris* sp.), marsh bellflower (*Campanula aparinoides*), and a broom-sedge (*Andropogon glomeratus*). In 2009 a thinning project was done prior to the first planned burn to remove some of the heavy woody encroachment thereby decreasing shading. This year it was finally burned under marginal conditions with very modest results. Originally, some of the surrounding forest edge was included within the unit boundary, but due to time of day, fuel moisture, and the cumulative years of succession, only the core “open” area of the field was burned. Fire pulled off the line with low to moderate intensity initially then quickly died down requiring several interior strips to be pulled through the field, which resulted in roughly half the unit being burned with an overall patchy spread. There was very little impact to the woody encroachment during this rotation, and given the current state of succession that this unit has reached it will likely require some additional level of mechanical thinning to begin to restore this area to an open marsh. Hence, further discussion and direction is needed between Fire Management and other concerned GRSM Resource Management staff to determine: the priority and goals of this unit for long term management, the type and degree of mechanical thinning desired, if the current burn frequency is adequate, and what additional funding and personnel are needed to accomplish the goals.

Three Year Review of the Cades Cove Program

After 3 years of implementing the current burn rotation, GRSM Fire Management, along with the combined help of GRSM staff from vegetation management, wildlife management, law enforcement, and resource education as well as help from other parks including CUGA and KIMO, has been largely successful at completing assigned burn projects on schedule. Additionally, fall burning has been reasonably successful at maintaining a significant portion of Cades Cove in an open grassland state. However, there are certain areas where the frequency and seasonality of burns appear to be inadequate for some species of woody encroachment. A related issue is that numerous small areas have either been excluded or have experienced patchy burns,

effectively decreasing the frequency even more than three years in these areas. These problem areas include: the sweetgum encroachment in portions of units along the Abrams Creek corridor such as Old Field, Cemetery Marsh, Cable House, and Elijah Oliver, the pitch pine and Virginia pine encroachment along the forest edges that surround many of the fields, and possibly even the yellow-poplar encroachment that was seen in the Tipton Oliver unit during this rotation.

Sweetgum appears to be the most aggressive of this group, because, despite being top-killed, over the course of 3 years it appears to increase in number of stems and it attains a size that becomes more difficult to top-kill again. Hence, it would be worth choosing one or more areas, such as Old Field and the southwest end of Cemetery Marsh to experiment with annual burning, growing season burns, and/or mechanical treatments in conjunction with burning. Yellow pine encroachment along the edge of units might be best handled with some initial thinning with chainsaw that is later maintained with the tractor and brush-hog. The issue of yellow-poplar has not been observed as closely as sweetgum to determine the vigor of resprouts over a 3 year rotation period, but it is possible that experimenting with similar control methods could be an effective option as well. A goal of the monitoring crew in the coming year is to conduct surveys and develop a map that depicts the worst areas of woody encroachment.

On a final note, blackberry resprouting is another common problem in many of the field units that would likely be controlled better by annual burns and growing season burning, but after a 3 year rotation the blackberry encroachment appears to be marginally maintained at its 2009 preburn level. However, longer term monitoring might prove that this frequency is inadequate.

The final recommendation here is for a combined discussion between Fire Management and all other concerned GRSM Resource Management staff that reevaluates the goals and objectives with consideration to the current monitoring input, and considers additional management options.

IV. Long term Monitoring Results

The data collected during 2011 did not offer significant improvement to the results that were included in last year's report, so there were no updates made to **Table 2** this year.

(Copied from last year's report) 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 the long term objectives provide for 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.

Citation and Abstract of 2011 publication

Jenkins, M.A., R. Klein, V. McDaniel. 2011. **Yellow pine regeneration as a function of fire severity and post-burn stand structure in the southern Appalachian Mountains.** *Forest Ecology and Management* 262. Pp. 681-691.

Abstract:

We used pre- and post-burn fire effects data from six prescribed burns to examine post-burn threshold effects of stand structure (understory density, overstory density, shrub cover, duff depth, and total fuel load) on the regeneration of yellow pine (*Pinus* subgenus *Diploxylon*) seedlings and cover of herbaceous vegetation in six prescribed-fire management units located within western Great Smoky Mountains National Park (GSMNP) in east Tennessee, USA. We also evaluated the utility of the Keetch–Byram Drought Index (KBDI) as a predictor of post-burn stand and fuel conditions by comparing post-burn stand variables for different ranges of KBDI (23–78; more wet, and 328–368; more dry). We found that yellow pine seedlings were effectively absent in post-burn forests until overstory density was reduced over 40%, understory density was reduced over 80%, and post-burn shrub cover was 10% or less. We also observed that a reduction in total fuels of 60% and a post-burn duff layer depth of less than four cm were required for successful regeneration of yellow pine. Total herbaceous species cover exhibited near identical responses with increased cover following an 80% reduction in understory density and a post-burn duff depth of less than 4 cm. We observed strong positive relationships between high KBDI values and burn severity, changes in forest structure, reductions in fuels, and post-burn yellow pine reproduction. We observed continuous recruitment of yellow pine seedlings 5 years after fire in high KBDI burns while low KBDI burns showed little change in yellow pine density through time. An intense outbreak of the southern pine beetle (SPB; *Dendroctonus frontalis*) occurred within 2 years of our high KBDI burns and reduced shading resulting from overstory mortality likely enhanced the survival of yellow pine seedlings. The results of this study provide targets for the application of prescribed fire to restore yellow pine in the southern Appalachians. Continued research and monitoring will help determine how prescribed fire can best be applied in combination with other disturbance agents such as SPB to perpetuate yellow pine forests.

V. Discussion and Comments

The fire ecology/fire effects team continued to provide valuable support to the GRSM prescribed fire program, wildfire management, GRSM resource management, and the federal incident management system in 2011. While the main focus of the program remains collecting ecological data to support the prescribed fire program, team members have increasingly provided service and expertise to a host of operational, planning, and scientific efforts that advance NPS fuels-management efforts.

As discussed in the review of the 2011 tornado, events have conspired to provoke a review of the fire-effects monitoring design, which will begin in the coming year. It should be emphasized that safety and access are not the only issues driving the need for a program review, though they are the most important. Given the large degree of heterogeneity within and between both prescribed burns and wildfires, it would also be beneficial to increase our sample size in order to provide a better description of the spatial and temporal dynamics that are occurring across the landscape as a result of fires in the park. One possible goal would be a model of vegetation and fuels effects that relates to the dNBR data that was highlighted in section III of this report. Such a model would be of tremendous value to NPS fuels management and could provide insights into fire ecology across a broad geographical range.

Kings Mountain National Military Park (KIMO): 2011 Fire Effects Monitoring Annual Report

I. Overview

The monitoring crew completed all scheduled plot reads at KIMO in 2011, and it was a substantial number (32 plot visits). Many of these plot visits were in the Saddleback/North Brushy complex that was burned during spring 2011, which is reviewed in *Section III* of this report. The crew also spent a lot of time conducting monitoring surveys within these areas and within areas scheduled to burn in 2012. The surveys were generally very effective at documenting observations and recommendations for improvements to the fuels management program, and much of that information was synthesized and communicated to KIMO fire managers and the GRSM Wildland Fire Module during discussions about the upcoming burns.

Fire ecology support for KIMO during 2011 centered on development and improved communication of site-specific objectives for upcoming burns. The ecologist made several visits to KIMO during the year, to participate in the Saddleback burn, conduct long-term monitoring, participate in burn unit surveys, and for a planning meeting with fire management staff.

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. 2011 Prescribed Burns

Saddleback/North Brushy Mtn.

The Saddleback burn of 2011 was a significant event, both in terms of prescribed fire operations and fire effects. As such, there is a great deal that can and should be learned from it. The following review is lengthier than usual, but we hope it serves as resource for building knowledge and expertise in prescribed burning.

Background

February 18, 2011 marked the third prescribed burn for the Saddleback area, a burn unit comprised of two adjacent, formerly separate units, Brown’s Mountain and South Y-S Road. Brown’s Mountain was first burned on 6/11/01 and Y-S on 3/24/02, then both units were combined into Saddleback during the second entry on 4/20/04 (**Table 1**). North Brushy Mountain also received a third, unplanned, burn on 2/18/11 as part of a contingency plan when fire from the adjacent Saddleback unit spotted across the Brown’s Mountain Trail and was unable to be contained. North Brushy was first burned on 6/24/03 then again on 3/12/08.

Table 1: Summary of Prescribed Burn History for Saddleback (Brown’s Mtn. and Y&S Combined) and North Brushy Mtn., KIMO, SC

Burn Unit	1 st Entry	2 nd Entry	3 rd Entry
Brown’s Mtn.	6/11/01	-	-
South Y-S	3/24/02	-	-
Saddleback	-	4/20/04	2/18/11
North Brushy	6/24/03	3/12/08	2/18/11

Saddleback Site Description and Rx Burn History

The Brown’s Mountain unit is located in the west end of the park bounded by a powerline corridor on the west side, lookout tower road on the south side, and Brown’s Mountain Trail on the east side. This unit is largely dominated by dry, thin-soiled chestnut oak (*Quercus montana*) forest, along with some scattered stands of shortleaf pine (*Pinus echinata*) on the mid to upper west facing slopes, and globally rare blackjack oak (*Quercus marilandica*) barrens located on a rocky wind-swept ridge in the northeast section of the unit. Very little information exists for the first entry burn into this unit but based on time of year (forest canopy in full leaf-out) and weather conditions on the day of the burn (low RH only 65 with chance of afternoon precipitation) it is presumed that the fire severity was fairly low.

South Y-S Road is located adjacent to the northeast boundary of the Brown’s Mountain burn unit, and is bounded by the Yorkville-Shelbyville Road to the north, the Brown’s Mountain Trail to the south and Main Park Drive to the east. This unit, like Brown’s Mountain, is largely dominated by dry, rocky thin-soiled chestnut oak forest along with some small shortleaf pine stands along western end of the main ridge. The first entry into Y-S included lower RH’s and erratic winds along with some potential low slope ignition patterns, which result in low to moderate severity through most of the unit and moderate to high severity effects in parts of the west end of the unit. Interestingly, following some overstory mortality plot QUMO 12, a thicket of shortleaf pine regeneration became established.

Both of these units were combined during the second burn (2004) and the resulting burn unit was renamed Saddleback. Variable winds, low relative humidity, unstable atmospheric conditions, aggressive firing techniques with respect to slope, aspect and topography, and possibly dry fuel conditions all contributed to extreme fire behavior. Fire whirls, spotting, and torching of mountain laurel were reported on several sections of the unit. Large canopy gaps adjacent to the fireline were created all along the powerline corridor, along the Lookout Tower Road, along the east slope of the ridge across Brown’s Mountain Trail from Joe’s Mountain, and the southeast end of the ridge just north of Stonehouse Branch along the Brown’s Mountain Trail.

North Brushy Site Description and Rx Burn History

North Brushy Ridge is located along the south side of the Brown’s Mountain Trail adjacent to the Y-S and Brown’s Mountain units, and it is bounded by main park drive to the east around the park headquarters and maintenance area and Piedmont Road to the south. The main ridgeline of this unit is characterized by rocky wind-swept blackjack oak barrens with chestnut oak and shortleaf pine commonly occurring in the overstory. Sparkleberry (*Vaccinium arboreum*) and mountain laurel (*Kalmia latifolia*) shrubs are common in the understory, a variety of blueberries

(*Vaccinium* sp.) often form a clonal ground cover, and a variety of grasses such as little bluestem (*Schizachyrium scoparium*), downy oat grass (*Danthonia sericea*), and broom-sedge (*Andropogon virginicus*) occur in the herb layer. Additionally, the spur ridges to the north are dominated by dry chestnut oak forest, and some scattered stands of shortleaf pine occur along the mid to upper south and west facing slopes. The first entry burn for North Brushy Ridge was conducted under somewhat similar conditions to the first entry for Brown's Mountain, full forest canopy leaf-out and moderate RH's (low to high 40's). Ignition occurred over a two day period, with hand ignitors targeting the main ridgeline and spur ridges, generally allowing fire to back down of the ridge. Apparently the severity was low overall with the most active fire behavior in the blackjack oak barrens and chestnut oak forest that dominate the ridgeline and upper slopes. The second entry burn into this unit was had more complete coverage of the unit, with the overall severity observed to be low. There were some occasional 1-2 chain long upslope runs due to the aerial ignition pattern that resulted in small areas of moderate to high intensity fire behavior, and there was a 3 acre area of high severity fire in the drainage off the southeast slope of Joe's Mountain with 7 meter char height on several trees.

Summary of 2011 Rx Burn

Leading into the third burn, there were several factors that significantly affected the results. The region was in a period of long term drying, increasing availability of fuels such as mountain laurel which would greatly increase the intensity and spread of fire. The previous burn had created numerous snags and heavy fuel buildup right along control lines. Hence, there was significant prep work that needed to be done in a very small window of time, which contributed to a delay in burning that was marked by increasingly drier conditions.

The burn started early on the northern end and fire spread was initially minimal in compact fuels. By 1000, however, drier conditions and localized wind effects were producing intense fire whirls greater than 20' in height. By 1200, ignition along the powerline at the northwest corner of the unit was producing 10-15' flames from Mt. Laurel resprout clusters, and causing multiple spots in the grassy powerline ROW. The spots were dealt with after some fast action, and the decision was made to continue with the burn.

Ground forces shifted to the south end near the Brown's Mt. tower by 1300. Black-lining began to the east and west while aerial ignition was applied to the interior of the unit. Fire was very active in the deep oak litter, and ignitors had to work hard to avoid pushing too much heat toward the line. After ignitors on the east had progressed past the trail junction below Brown's Mt, they picked up a couple spots over the line that quickly ran toward Joe's Mt. and became impossible to attack directly. Shortly after this time, crews shifted to a contingency plan to burn out the North Brushy unit in its entirety.

As the eastern team got a handle on the contingency operation, the western ignition team continued with ignitions to the powerline and then proceeded north along the ROW. Time was around 1700 and daylight was beginning to fade. Due to a long delay with the east-side slopover, and the inability of the helo to bring fire down off the ridge toward the ROW, the three west-side ignitors were left with over a mile of ROW to black-line that was far downslope from the main fire. Nearly this entire stretch had been heavily impacted by the 2004 fire, and the objectives for the day were to use low-intensity fire on this burn to avoid worsening an already

bad situation. The crew worked hard to mitigate the intensity of upslope runs, but the amount of ground to cover and the thickness of vegetation made that nearly impossible. Fire behavior off the line was moderate in intensity, and increased in intensity on its run to the ridge. By the time ignition along the west ROW was complete (2030), there were numerous jackpots burning out and hundreds of snags with fire all the way to the top along the entire ROW.

The North Brushy contingency operation was complete by 2230. Both fires were contained within their boundaries the following morning, and the burn crew held them despite red-flag conditions the following day.

Summary of Fire Effects

Figure 1: Summary Map of 2011 Saddleback Fire Effects

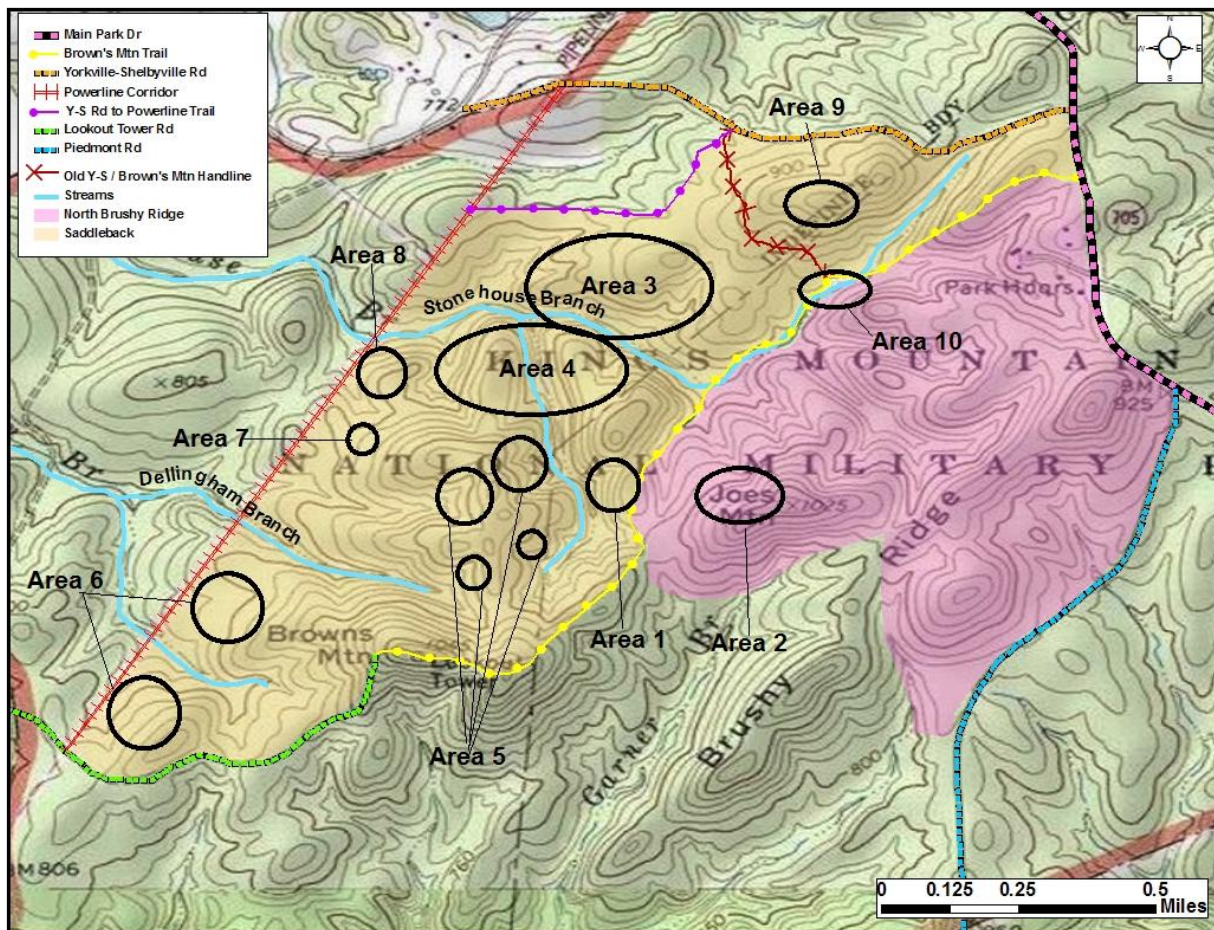


Table 2: Summary Table Describing Areas of Interest Displayed in Figure 1.

Map Location ID	Area Description
Area 1	A intense headfire came up this slope out from the bottom of the drainage as evidenced from the removal of most of the litter and duff , mountain laurel burned down to charred stubs, and char heights ranging from 2-8 meters on the mid to upper slope overstory trees. Near this location at the head of the drainage is where the fire spotted across Brown's Mtn. Trail into the North Brushy burn unit. An additional spot occurred around the same time from further north on the trail, and the two spots appear to have merged and made a headfire run up the northwest side of Joe's Mtn.
Area 2	This area marks the headfire run up Joe's Mtn. from the Saddleback spot fires. Similar to Area 1, litter and duff were significantly reduced, mountain laurel was burned severely enough that only the charred main stem remained, and most of the oak and roughly half the shortleaf pine overstory were killed over approx. 1acre. The majority of the rest of the North Brushy unit burned in stark contrast to this initial headfire area, with very low impact to the existing mid and overstory.
Area 3	The southern slope of this ridge experienced a large scale headfire run from the bottom of the slope along Stonehouse Branch that could only have been the result of intentional aerial ignition directly along the north side of Stonehouse. This resulted in a large scale canopy gap with an estimated 75% mortality of oak overstory and 95-100% scorch common on overstory shortleaf pine. Much of the remaining live oak is comprised of chestnut oak with heavy epicormic sprouting, which could indicate mortality over time. Most of the shortleaf pine appeared to recover from the heavy scorch, which is not uncommon for this species, indicating its ability to withstand severe fire and which explains its occurrence on the driest aspects and orientation on the mid to upper slopes where a head fire would reach its greatest intensity. Over the long term, drastic large scale overstory removal from a single fire event such as this is usual a makes regeneration of desired oak species more difficult with the removal of seed trees and release of undesirable species which resprout and grow vigorously, outcompeting any oak seedling (as his has been clearly illustrated from the multiple canopy gaps created during the second entry into the saddleback unit).
Area 4	As with Area 3 this location experienced headfire runs resulting in large scale overstory removal due to aerial ignition from the bottom of the slope along the south side of Stonehouse Branch. Fire apparently became established in the mouth of the drainage indicated on the map, moving up and out of the drainage and unto the adjacent slopes. The north end of the eastern ridge was mostly comprised of chestnut oak forest which received heavy canopy mortality and left the remaining live trees severely stressed. The ridge to the west, however, is an open blackjack oak-chestnut oak rockland area with open shortleaf pine stands along the upper portion of the western slope. Mountain laurel was common coming up out of the drainage onto the western slope,

	which carried the fire with a high intensity resulting in 60 % overstory mortality of the upper slope shortleaf pine and evidence of stress on the remaining live trees. The upper western slope and ridgetop on the north end of the west ridge experienced good response from little bluestem, forest tickseed (<i>Coreopsis major</i>), and bracken fern (<i>Pteridium aquilinum</i>), along with scattered seedlings of bristly locust (<i>Robinia hispida</i>) and resprouts from sparkleberry and mountain laurel. Due to the dry, rocky thin-soiled conditions on this ridge there is very little competition from undesirable overstory tree species, and the herbaceous response appears to be a positive step in restoring this community type.
Area 5	These areas at the head of most of the drainages indicate a scattering of small canopy gaps that were created or enlarged from indiscriminant aerial ignition. Apparently, the helicopter ignition gridded across the landscape without regard to topography, rather than lighting just the main ridgeline and major spurs or even at least following the contours.
Area 6	Both of these locations where preexisting canopy gaps from the second entry burn, and are somewhat representative of a significant portion of the powerline corridor. The oak overstory had been largely removed in these areas creating a resprout thicket of undesirable tree species including sourwood (<i>Oxydendrum arboreum</i>), red maple (<i>Acer rubrum</i>), blackgum (<i>Nyssa sylvatica</i>), yellow-poplar, and sweetgum. Despite the sparse, more compact, and less flammable nature of the leaf litter from these species, these areas burned with moderate to high intensity due to increased sunlight exposure along the powerline and long term drying in the region. Thus, almost all of these undesired resprouts were top-killed, but they also all sprouted back with the same vigor as before. It appears the only effective approach to these areas may be the use of frequent growing season burns to start draining the root reserves of these resprouts.
Area 7	This area is at the lower end of a shortleaf pine stand and several shortleaf seedling that originated from the second burn were resprouting after been top-killed in the last burn.
Area 8	This is where ignition ended on the Saddleback burn unit. Mountain laurel coming out of the Stonehouse Branch drainage was group torching on the night of the burn as ignition operations were tying fire into Stonehouse Branch after dark. Most of the laurel on the upper portion of this slope was top-killed with significant mortality in the overstory due to fire intensity. The availability of live mountain laurel leaves to burn was one driving factor in the overall intensity and severity across this entire burn unit. More attention should be given to long term drying trends when considering burns in the future as the level of drought made controlling fire intensity and spotting potential very difficult during this burn.
Area 9	This location roughly marks the shortleaf pine regeneration thicket that was created from the first Y-S burn. Despite significant scorch, most of these pine saplings survived the recent burn.
Area 10	This area indicates a growing problem in the riparian areas along the

stream corridors in this park. What was once native vegetation is now a continuous monoculture of invasive Japanese stilt-grass (*Microstegium vimineum*). It would appear that repeatedly forcing fire into these riparian areas, where it would have only occasionally backed into during a natural fire event, has helped spread this non-native, invasive plant by increasing disturbance and creating a favorable seedbed. Moreover, the cured leaves of this species carry fire very well, thereby increasing the intensity and spread of fire in an area that is sensitive to even low to moderate intensity. More consideration should be given to the ignition operations in riparian areas in the future, and exotic plant control measures should be taken whenever feasible.

Conclusions

- Ensure that adequate planning gets done and that prep and planning are coordinated
- Pay close attention to long-term drying trends and uncharacteristic weather
- Understand that long-term drying trends and uncharacteristic weather can affect different burn units very differently, depending on topography, vegetation, and past fire effects
- Understand specific objectives for each different site, and ignite accordingly
- Ensure that the helicopter can perform the operations necessary to achieve site-specific objectives
- Limit prep and ignition in creek bottoms to limit exotic plant spread and damage to fire sensitive species
- Consider using low-intensity growing-season burns to manage resprout thickets

IV. Long term Monitoring Results

The data collected during 2011 did not offer significant improvement to the results that were included in last year's report, so there were no updates made to **Table 3** this year. The following paragraph accompanies the table and is also copied from last year's report.

(Copied from last year's report) 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 the objectives provide for 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

The burn program at KIMO has done a great job at maintaining a park-wide burning rotation and has dramatically increased the habitat diversity throughout the park. There are numerous interesting sites that now have greater herbaceous species diversity and greater flower and fruit production of herbs and grasses. The range of structural effects, coupled with continued burning, ensures that foundation species like chestnut oak and shortleaf pine will continue to regenerate and anchor a variety of resilient forest types at KIMO.

Much has been learned about burning to restore oak and pine woodlands at KIMO, and the program continues to apply new information to planning and implementing fuels management and prescribed burning. The key to continued success is to adapt planning to include site specific considerations in selecting appropriate weather conditions and ignition strategies.

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
<i>Planning</i>	25%	Planning meetings at nearly every park in the cluster; Burn plan reviews; fire effects program planning; development of site-specific objectives for FY12 burns; Many large and small things.
<i>Presentations</i>	5%	Oral presentations at Rx-310 in Chattanooga, Burn Boss Training for NC State Parks, and for visiting scientist from Australia. Annual Report.
<i>NPS Meetings/ task groups</i>	2%	Continued involvement in GRSM Inventory and Monitoring workshops. Data management committee at GRSM.
<i>Interagency work</i>	5%	Steering team/Monitoring committee/DFC committee for Southern Blue Ridge FLN, Annual FLN Workshop.
<i>Fire Assignments</i>	8%	Lots of prescribed fire throughout SER. Module assignment at Okefenokee.
<i>Research</i>	5%	Continued as Federal cooperator on regional JFSP dendrochronology project and Indiana bat project; various roles interacting with researchers and mentoring students.
<i>Data Collection</i>	15%	Some fieldwork at every park. Plot work and qualitative surveys. Immediate postburn and growing season.
<i>Data management</i>	2%	Various
<i>Data analysis</i>	15%	Estimated amount of time spent performing analyses, including data summaries and statistical tests.
<i>Supervision/Admin</i>	10%	Hiring, supervision, travel, payroll, crew support, purchasing etc.
<i>Training</i>	3%	OJT for Firing Boss. Participation in various classes.
<i>Miscellaneous</i>	5%	Mostly communication.

Table 2. Fire Effects Crew Accomplishments/Focus Areas

Category	Percent Time	Notes
<i>FMH plots</i>	40%	Plot data collecting and preparing plot folders and equipment for field. Also, assisted NATR and SHEN Fire Effects Team and Pisgah NF Fire Staff in completing their plot work
<i>Prescribed fire projects</i>	24%	Crew completed scouting/pre-planning of RX Burn Units and assisted with preparation and operations of prescribed fires in SE region; this includes post-burn monitoring surveys
<i>Data entry</i>	13%	Data entry and management
<i>WUI plots</i>	0%	
<i>CBI plots</i>	0%	
<i>Other plot work</i>	0%	See post-burn monitoring surveys under “prescribed fire projects”
<i>Fire Assignments</i>	10%	• Lead and 1 crewmember completed 14-Day Assignment in FL/GA • Various members of crew assisted with 4 separate in-park (GRSM) wildfires • Lead and assistant completed 14-Day Assignment on West Tx IA Engine Crew • Lead and 1 crewmember worked on SER Helicopter detail
<i>Non-fire fuels projects</i>	2%	Crew member completed 45-day detailed as READ to Gulf Oil Spill-Gulf Islands National Seashore
<i>Data analysis</i>	0%	
<i>Supervision/Admin</i>	10%	Lead and assistant supervised crew and maintained misc travel, time and purchasing paperwork
<i>Training</i>	1%	Lead and Assistant Attended Fire and Oaks Conference, Springfield, MO, 2 Crew Members attended Eastern Fire Effects Summit at SHEN

D. Additional Program Information

Table 6. Planning - 2011

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

Table 7. Monitoring - 2011

Park	% 2011 Data Entered	% 2011 Data Quality Checked	# Prescribed Fires Monitored*	# Non-fire Fuels Treatments Monitored*	# Wildfires Monitored*	# BAER Treatments Monitored*
BISO	100%	100%	1	0	0	0
BLRI	100%	100%	0	0	0	0
CONG	100%	100%	0	0	0	0
COWP	100%	100%	0	0	0	0
CUGA	100%	100%	1	0	0	0
GRSM	100%	100%	5	0	3	0
KIMO	100%	100%	1	0	0	0

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

Table 8. Communicating Results - 2011

Park	# of Project Monitoring Reports completed in 2011	# of Annual meeting(s) with Park staff	# of Formal presentations of results	Do you use Minitab?*
BISO	1	1	0	Yes
BLRI	0	1	0	Yes
CONG	1	3	0	Yes
COWP	0	1	0	Yes
CUGA	3	1	0	Yes
GRSM	2	3	3	Yes
KIMO	3	3	0	Yes

* This information will help to assess Minitab multi-user license needs.

Table 9. Research - 2011

Park	Are research needs identified in FMP or Monitoring Plan? (yes or no)	# of Proposals Submitted in 2011	# of Proposals Funded in 2011	# of Research Projects Supported in 2011*	Additional Comments
BISO	yes	0	0	0	
BLRI	yes	0	0	0	
CONG	yes	0	0	0	
COWP	yes	0	0	0	
CUGA	yes	0	0	0	
GRSM	yes	2	0	2	
KIMO	yes	0	0	0	

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

The End