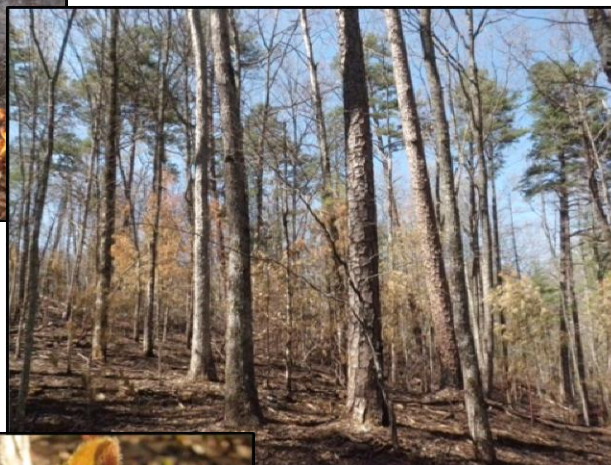




Southern Appalachian/Piedmont Fire Effects Monitoring Annual Report, 2014



On the Cover:

Series of photos illustrating the stages of fire monitoring at the Lynn Hollow burn site in GRSM.

Top Photo: March 21, 2014 prescribed burn of Lynn Hollow. This was the second entry of fire in to the north unit of Lynn Hollow.

Center Photo: April 16, 2014. Immediate post-burn effects of prescribed burning in the south unit of Lynn Hollow. Note the intact shortleaf pine canopy and the heavily scorched white pine in the understory.

Bottom Photo: May 6, 2014. Short-term fire effects at Lynn Hollow included a profusion of pink lady slipper (*Cypripedium acaule*) blooms. Plants were observed throughout the unit, and photos of them were featured in local and regional newspapers.

Southern Appalachian/Piedmont Fire Effects Monitoring Annual Report, 2014

Robert N. Klein Jr.

E. Wylie Paxton

J. Matthew Wood

National Park Service

Southern Appalachian/Piedmont Fire Effects Monitoring Program

Great Smoky Mountains National Park

107 Park Headquarters Road

Gatlinburg, TN 37738

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Introduction

The Southern Appalachian/Piedmont fire-effects monitoring team conducted pre-burn, short-term, and long-term vegetation and fuels monitoring at six NPS units during 2014 (**Table 1**), and also supported prescribed burning operations at six parks (**Table 2**). The annual total for plots completed was 93, which is a 72% increase from the 2013 total. Despite continued budget reductions for prescribed burning and fire-effects monitoring, the plot numbers in 2014 were buoyed by large burns at Cape Hatteras, Congaree, and Great Smoky Mountains – each of which contained numerous monitoring plots.

The Appalachian/Piedmont staff also provided key support for the 2000-acre Slant Rock/SE Complex prescribed burn and post-burn monitoring at Little River Canyon, as well as supporting long-term monitoring efforts of the US Forest Service on the Cherokee NF. This work could not have been completed without assistance from the Resource Management staff at Cape Hatteras, partner-funding support for work at Congaree, or the dedication and expertise of the crew.



Fire-Restored Pine Woodland at Congaree National Park

Overall, both prescribed burning and monitoring efforts were highly successful throughout the Appalachian/Piedmont park network in 2014. The *Bodie Island* burns at Cape Hatteras were viewed as a great success immediately following the burns, though continued monitoring of the 13 plots within these sites is needed to assess the impacts to exotic *Phragmites*. These burns also played a crucial role in increasing the confidence and skill of park and fire staff in managing hazardous coastal fuels.

The *Dark Ridge* burn at Cumberland Gap and the *Lynn Hollow* burn at Great Smoky Mountains both continued the trend of excellent planning and execution of mountain burns. Both burns produced outstanding fire effects, as confirmed by extensive post-burn monitoring. The *Lynn Hollow* burn, in particular, represents a major success for the fire program at Great Smokies. This burn is a model for successful management of old-growth shortleaf pine and oak woodland in a fire-prone Wildland-Urban-Interface setting. The success at Lynn Hollow will soon be featured as a Success Story for the National Cohesive Strategy.

The highlight of the year, however, was the May 5th burning of the *RCW/Hampton* units at Congaree (**see photo above**). The burn program there has been playing catch-up since missing 2-3 crucial burn rotations between 2006 and 2012, and the timing of these burns was exactly as prescribed to achieve the desired fire effects. Extensive post-burn monitoring revealed exceptional effects that represent renewed success and the continued restoration of the RCW and Harry Hampton sites. More complete discussions of 2014 burns, along with monitoring results, can be found in each park's respective section of this report.

**Table 1. Appalachian/Piedmont Fire Effects Monitoring Program:
2014 Plot Workload and Total Plots Installed**

Park	Monitoring Unit	Plot Type	Pre-burn 2014	Immed. Post 2014	Postburn (1-20 yrs) 2014	Annual Total (2014)	Total Plots
Big South Fork (BISO)	Fuels Transects	Fuel Transect			1	1	4
	Little Bluestem	FMH Forest Plot			1	1	4
	Shortleaf Pine	FMH Forest Plot				0	2
	White Oak	FMH Forest Plot			1	1	13
	LFEM	Modified FIREMON Species Composition			3	3	5
	CBI	CBI				0	9
Blue Ridge Parkway (BLRI)	Chestnut Oak	FMH Forest Plot				0	2
	Fuels Transects	Fuel Transect				0	6
	Photo Points	Photo Point				0	2
Cape Hatteras (CAHA)	Photo Points	Photo Point		12		12	29
Congaree (CONG)	Loblolly Pine	FMH Forest Plot		5	5	10	5
	Longleaf Pine	FMH Forest Plot		5	5	10	5
Cowpens (COWP)	Southern Red Oak	FMH Forest Plot				0	2
Cumberland Gap (CUGA)	Scarlet Oak	FMH Forest Plot		2	4	6	16
	LFEM	Modified FIREMON Species Composition			4	4	7
Great Smoky Mountains (GRSM)	Yellow Pine	FMH Forest Plot	2	2	7	11	29
	Scarlet Oak	FMH Forest Plot	1	1	2	4	16
	Black Oak	FMH Forest Plot		4	4	8	8
	LFEM	Modified FIREMON Species Composition			8	8	29
	Fuels Transect	Fuels Transect	2	1		3	3
	CBI					0	70
Kings Mountain (KIMO)	Blackjack Oak	FMH Forest Plot			1	1	8
	Chestnut Oak	FMH Forest Plot				0	21
	LFEM	Modified FIREMON Species Composition			6	6	18
Moore's Creek (MOCR)	Photo Points	Photo Point		2	2	4	2
Total			5	32	54	93	259

Table 2. Summary of 2014 Prescribed Burns and Monitoring

Park	Burn Unit	Plots?	Other Monitoring	Acres
Big South Fork	Mitchell Fields	No	Yes(FEMO)	44
Cape Hatteras National Seashore	Bodie Island 1.2	No	YES(FEMO)	1538
	Bodie Island 1.3	Yes (LFEM)	Yes(FEMO)	650
Congaree National Park	RCW	Yes (Full Plots)	Yes(Qualitative)	248
	Harry Hampton	Yes (Full Plots)	Yes(Qualitative)	259
	Red Bluff	Yes (Full Plots)	Yes(Qualitative)	156
	Dawsons	No	Yes(Qualitative)	200
Cumberland Gap	Dark Ridge A and B	Yes (Full Plots)	Yes(Qualitative)	165
Great Smoky Mountains	Lynn Hollow	Yes (Full Plots)	Yes(LFEM)	233
	Matthews Branch	Yes	Yes(FEMO)	275
	Old Field	No	Yes(FEMO)	85
	Cemetery Marsh	No	Yes(FEMO)	63
	Rowans	No	Yes(FEMO)	54
	Methodist Church	No	Yes(FEMO)	38
Moore's Creek	Savannah	Yes(Photopoints)	Yes(FEMO)	9
	West Unit	No	Yes(Qualitative)	6
	South Unit	No	Yes(Qualitative)	11
Total	17	8	17	4034

2014 saw significant changes in fire effects staffing. Huma Alvarado resigned her crew-member position to start a new life with her husband Sevn and their new daughter Asha in Asheville, NC. Huma had helped to anchor our crew for 7 years, and had been involved in our program off and on for over 11 years. Through her impressive work ethic, she made huge contributions to NPS fire monitoring and fire management, participating in numerous prescribed burns, wildfires, and western fire assignments. She will be missed.

Unfortunately, as things go, Huma's vacated permanent position was converted to a seasonal position during the 2014 NPS fire staffing realignment. Plans are to hire a seasonal crew-member to support our summer field monitoring. We hope to have someone on board by mid-May until the end of September.

Beyond Huma, the Fire Effects program continued to enjoy stability in staffing (**Table 3**), which contributes tremendously to our program's ability to support the NPS mission and NPS Fire Management goals. Specifically, it allows our program to: interpret fire effects in a broad range of habitats, help guide effective planning for all types of fire, support other fire-effects programs and other agencies, support education and major research, and help to improve management of natural resources throughout the eastern United States.

Table 3. Fire Ecology/Fire Effects Staffing 2014

Ecologist and Monitors	Starting Date	Ending Date	# of Pay Periods	READ Qualified (Yes or No)	Training and Development
Rob Klein (Fire Ecologist)	1/1/14	12/31/14	26	Yes	Assisted with prescribed fires at GRSM and LIRI. Attended Prescribed Fire in the Mid-south Conference and 9 th Fire Learning Network Meeting at Blue Ridge Escarpment; Fire Assignment as FFT1 California Wildfire.
Wylie Paxton (Lead Monitor)	1/1/14	12/31/14	26	Yes	Assisted with prescribed burns at BISO, GRSM, CONG, LIRI, CAHA, MOCR, Participated in Carolina Vegetation Survey PULSE, Attended Prescribed Fire in the Mid-south Conference; Worked with CUGA module on Fuels Project along BLRI.
Matt Wood (Assistant Lead)	1/1/14	12/31/14	26	No	Assisted with prescribed burns at GRSM, CONG, and LIRI. Assisted with Wildfires at GRSM
Bob Dellinger (Crewmember)	3/10/14	11/14	18	Yes	Assisted in Prescribed Fires at GRSM and CONG. Attended Prescribed Fire in the Mid-south Conference and 9 th Fire Learning Network Meeting at Blue Ridge Escarpment. ICT5 on Ramsey Cascade and Rocky Spur Wildfires at GRSM

Research Update

Research partnerships continue to provide invaluable data to fill in knowledge gaps and help guide our understanding of fire management. 2014 saw the completion of fascinating products from past research, additional data collection for ongoing research, and some very exciting starts to new projects. The fire-history study by the University of Tennessee and Texas A&M University, which began in 2006, continues to paint a picture of the long history of fire in the Great Smoky Mountains, and is shedding light on some of the key details for how fire operated on this landscape. New work by Cecil Frost is describing how fire historically interacted with landscape to shape vegetation in the monadnock forests of Kings Mountain in the South Carolina piedmont. These and other research partnerships are briefly described below. Facilitating great research and continued interest in the study our National Parks is a key role for our Fire Ecology Program, and these activities are well-aligned with the goals of the NPS Centennial ***Call to Action***. Please contact Rob Klein with any and all research needs, ideas, or interested partners.

Great Smoky Mountains National Park

Fire and Forest History from Soil Charcoal in Yellow Pine and Mixed Hardwood-Pine Forests in the Southern Appalachian Mountains, U.S.A. Doctoral Dissertation. 2013. Chris Underwood, University of Tennessee. (Dr. Sally Horn, UT)

This was the third doctoral dissertation to come out of the 2006 Appalachian Fire History study funded by the Joint Fire Science Program. The work for this particular dissertation was done wholly within the Great Smoky Mountains N.P., and the study sites were co-located with the dendrochronology sites of Lisa LaForest. This co-location allowed for the construction of unique, site-specific fire chronologies that provide coarse-scale evidence for fires over millennia and highly specific records of fire occurrence over centuries. Underwood completed his work in 2013, but it was not received by the park until 2014.

The information that this project provides is quite remarkable. In short, soil charcoal was ubiquitous, occurring at all sites, with radiocarbon dating of charcoal fragments between 9649 to 107 YBP. There was a pronounced increase in charcoal fragments dating between 4000 YBP to more-or-less present day, which may reflect increased fire resulting from changes in climate or changes in prehistoric human population size or lifeways. To quote from Chris's work:

The distribution of charcoal ages demonstrates that fires have been prevalent in the western portion of GRSM during much of the Holocene, especially from ca. 4000 to 100 cal yr BP. The older charcoal fragments, although not as abundant as the younger ones, provide evidence that fires occurred at the study sites during the early Holocene.

Perhaps even more remarkably, this study was the first to use taxonomically identified soil charcoal in an attempt to reconstruct ancient forest composition in the southern Appalachians. Using magnification, the author was able to observe the anatomical structure of the wood preserved in the charcoal fragments, and thus demonstrate the presence of trees at the generic or even the sub-generic level. For example, during the period between 2000-3000 YBP at the

Rabbit Creek Trail study site, approximately 57% of charcoal fragments were identified as yellow pine (*Pinus* subgenus *Diploxylon*), 27% as American chestnut (*Castanea dentata*), and 16% as oak spp. (*Quercus* spp.). Though it is a large step to go from proportions of charcoal fragments to actual forest composition, this data nonetheless provides direct physical evidence for the presence of certain species or genera in conjunction with evidence of fire at specific locations. Again, to borrow directly from Chris's work:

*This research showed that fires have burned on this landscape for millennia.
Taxonomic identification of charcoal showed the forests that burned were mostly
composed of southern yellow pine, eastern white pine, American chestnut, and oak.*

Simulating Historic Landscape Patterns of Fire in the Southern Appalachian Mountains: Implications for Fire History and Management. M.S. Thesis. 2014.

Ellen Gass, Texas A&M University. (Dr. Charles Lafon, TAMU)

This interesting project also grew out the original JFSP Appalachian Fire History Study, and was conducted under the supervision of Dr. Charles Lafon at Texas A&M. This work used reconstructed historic-vegetation composition and structure, along with the Fire Area Simulator software (FARSITE) to model how fires would have spread across the pre-Park landscape. The study area was the western end of the Park. The results of this analysis suggest that the mean area of historic fires would have been much larger than fires on the current landscape (567 ha vs. 45 ha, or 1440 ac vs. 114 ac), largely due to more open forest structure and greater amounts of flammable herbaceous fuel under the historical model.

Coupled with these larger fires, *the current lightning ignition rate* (0.46/yr) resulted in a modeled fire cycle of 120-135 years (fire cycle = average number of years required to burn the area equivalent to a defined area, i.e. the 36,000ha west-end of GRSM). Although this is much shorter than the suppression-era fire rotation for the park (25,000 – 30,000 years), it still does not account for the fire frequency determined by recent dendrochronology research in the Park. What this means is that historically, there would had to have been either: A.) a higher lightning ignition rate, or B.) anthropogenic ignitions. Assuming that the rate of lightning ignitions has not changed from historical times, the author calculates that 4-7 human-caused ignitions within or adjacent to the park would have been required to maintain the fire frequency observed in fire scars.

In a nutshell, unsuppressed historic fires resulted in vegetation features that created a feedback loop by encouraging more frequent ignitions and larger fires. This feedback resulted in a landscape process that functioned to maintain fire-associated vegetation (open, grassy) across broad areas within the Park, which matches published research into the Park's historical vegetation [See MacKenzie and White (1998) and Harrod, White, Harmon (1998)]. Though lightning fires were likely responsible for helping to maintain this feedback process, a small number of anthropogenic ignitions would have also been required.

dNBR Imagery and Xeric Pine-Oak Forest Stand Characteristics for Fires of Different Severity in Great Smoky Mountains National Park. M.S. Thesis. 2014.
Scott Abila, Western Carolina University. (Dr. Laura DeWald, WCU)

Remotely-sensed fire severity maps (aka dNBR) have been available as a fire effects monitoring tool since approximately 2000, and many current and past fire effects staff have contributed to the collection on ground-truthing data over the years to make these maps more meaningful. For this study, Mr. Abila used 60 CBI plots from the GRSM database, and added an additional 109 plots from a total of nine prescribed or wildfires to model the relationship between remotely-sensed severity and ground-based observations of severity. Overall, his model was highly significant ($p < 0.001$) and had an $R^2 = 0.81$, which convincingly demonstrates that on-the ground severity effects can be predicted from satellite imagery.

This study also examined vegetation responses to varying levels of burn severity in a subset of 48 plots. Results include significantly lower overstory density in sites classified as “High” severity, and significantly greater density of oak regeneration in “Moderate” severity sites. These findings are in keeping with observed fire effects, though additional studies will be needed to adequately characterize commonly-used severity classes.

Avian Communities of Fire-Impacted Areas within GRSM. M.S. Thesis work, ongoing.
Eli Rose, North Carolina State University. (Dr. Ted Simons, NC State)

This was the third and final year for field data collection of this exciting project. Preliminary findings were presented at the 2014 Great Smoky Mountains Science Colloquium, and the completed thesis is expected in 2015. It is expected that this ground-breaking research will add a significant dimension to our regional understanding concerning the role of fire in mediating landscape-scale diversity of bird communities.

Effects of Fire Severity on the Herbaceous Plant Species of Pine-Oak Forests in Great Smoky Mountains National Park. M.S. Thesis work, ongoing.
Sean Binninger, Western Carolina University. (Dr. Laura DeWald, WCU)

This is brand-new project that is just getting underway, with plans for fieldwork to begin in 2015. The fundamental idea is to determine if herbaceous species composition and/or abundance change following fire, and if so, whether such changes can be predicted by remotely-sensed fire severity maps. This exciting research gets to the heart of fire-restoration goals at the park, and was recently awarded a Carlos C. Campbell Memorial Fellowship by the Great Smoky Mountains Conservation Association.

Kings Mountains National Military Park

Pre-settlement Vegetation and Fire Regimes at Kings Mountains National Military Park and Cowpens National Battlefield. NPS Fuels Reserve Research, ongoing.

Dr. Cecil Frost

This project was awarded funding during early 2014, and work began soon after. Dr. Frost has made several visits to each of these sites to gather field data and geospatial data for his analysis. The models of historic vegetation and fire frequency will be welcome additions to restoration planning at these parks.

Big South Fork National River and Recreation Area

Monitoring Bat Assemblages at BISO by Comparing Prescribed Burn Areas to Adjacent Untreated Areas. NPS PMIS Project, ongoing.

Leanne Burns (M.S. Candidate), Clemson University. Dr. Susan Loeb (USFS SRS)

Staff at BISO completed a PMIS proposal to study the use of burned sites as habitat for several species of bats. This project was undertaken to determine if fire management activities, specifically prescribed burning, were having a detrimental impact on bat habitat, and also to provide data for more effective compliance with the Endangered Species Act. The Fire Ecologist and Fire Effects Monitoring crew have supported this project by providing researchers with polygon data for burned sites, as well as remotely-sensed burn severity maps.

Supplemental Literature

from:

Restoration in the Southern Appalachians: A Dialogue among Scientists, Planners, and Land Managers (USFS-GTR-SRS-189)

W.T. Rankin and Nancy Herbert, Editors

1.8 How do we restore fire to ecosystems where it has been excluded for many years?

— **Rob Klein**, Great Smoky Mountains National Park, Gatlinburg, TN

Fire has a long history in the Southern Appalachian landscape. Soil charcoal, tree-ring scars, and fire-adapted vegetation all provide evidence for the role of fire as a natural process over the past several thousand years (Aldrich and others 2010, Fesenmyer and Christensen 2010, Flatley and others 2013, Zobel 1969). Beginning in the early 20th century, however, land managers in the Southern Appalachians began to prevent or suppress forest fires, effectively excluding fire from the landscape for nearly 80 years (Aldrich and others 2010, Flatley and others 2013). Long-term exclusion of fire has led to major changes in forest structure, function, and composition, particularly among forest types dominated by yellow pines and oaks. For example, excluding fire has increased the density of fire-sensitive trees and shrubs, which, in turn, have prevented pine and oak regeneration, shaded out grasses and forbs, and reduced the diversity of vegetation across the Southern Appalachians (Harrod and others 1998, 2000; Turrill and others 1995).

Since the mid-1990s, land managers throughout the Appalachians have sought to use natural and prescribed fires to reverse the effects of fire exclusion. Fire exclusion, however, has contributed to a buildup of wildland fuels that make wildland fires more difficult to control, and that pose a threat to forest health: when these forests eventually burn, they often burn with undesirable intensity and/or severity (Reilly and others 2012; Vose 2000, 2003). As a result, land managers restoring fire in the Southern Appalachians face two interrelated questions: first, how to effectively reduce hazardous fuels, and second, how to restore fire-dependent communities, especially pine, pine and oak, and oak forests, while minimizing undesirable effects.

Hazardous fuels

Wildland fuels in Appalachian forests fall into two general categories—live and dead. Live fuels consist primarily of evergreen shrubs, particularly mountain laurel, that can pose serious problems for fire control, but do not typically contribute significantly to available fuels during landscape-level burns. Dead fuels, on the other hand, are flammable vegetation at or near the forest surface, such as leaf litter, duff, and woody debris. Organic duff is the most common form of dead fuel (50-70 percent of the total). Other dead fuels include litter (10-20 percent) and logs >3 inches in diameter (also called 1,000-hour fuels, 10-20 percent). These fuel classes are not consumed at the same rate by dormant-season burning (Jenkins and others 2011, Vose and others 1999, Waldrop and others 2010). Dormant-seasons burns, which occur in late winter and early spring, consume relatively high amounts of litter, but most of the heavier, longer-burning fuels are not consumed.

In contrast, Jenkins and others (2011) found late summer and fall burns consumed a much higher percentage of duff and 1,000-hour fuels. These growing-season burns generally coincided with the annual peak of the drought index for the region (as measured by the Keetch-Byram Drought Index; Keetch and Byram 1968). Although higher levels of heavy fuel consumption were associated with successful pine regeneration, they were also strongly correlated with higher levels of mortality in the pine and oak overstory, which led to large increases in fuel loading as dead trees fell to the ground. In addition, growing-season burns and wildland fires frequently increase the rate at which nonnative plants invade the community (see Kuppinger 2008).

Pine and oak restoration

Specific objectives for restoring pine and oak communities usually center on reducing the abundance of fire-sensitive trees and shrubs, increasing pine and oak regeneration, and increasing the abundance of grasses and forbs. Several burning techniques have been used to achieve these objectives, with mixed results.

Single, and even multiple, low-intensity burns (backing/flanking fires with flame length <3 feet) during the dormant season have not achieved objectives for pine and oak restoration (Chiang and others 2005, Elliott and Vose 2005a, Jenkins and others 2011). In general, pine and/or oak regeneration did not increase following low-intensity burns, and, although all of the studies documented initial reductions in fire-sensitive trees and shrubs, these and other studies also documented prolific and repeated basal resprouting for many of these species.

High-intensity burns (headfires with flame length >8 feet) have also been used during the dormant/early season to address pine and oak restoration objectives. A common response to high-intensity, early-season burns, which has not been widely reported, is for these fires to kill large numbers of overstory trees, creating large, stand-level gaps that subsequently become dominated by hardwood resprouts. This can happen with fires at any time of the year, although pines can regenerate after late-season fires where a seed source exists (Jenkins and others 2011). High-intensity burns have been shown to be successful in regenerating Table Mountain pine (Waldrop and Brose 1999), and may contribute to oak regeneration in formerly pine-dominated sites (Elliott and others 2009). In general, however, these types of fires are not effective in regenerating oak stands, and are not recommended for restoration projects, due to concerns about fire control, burn effectiveness, and the loss of seed trees (Brose and others 2006, Elliott and others 2009, Jenkins and others 2011, Waldrop and Brose 1999).

In summary, we have found the combination of vegetation change and fuel accumulation attributed to fire exclusion, coupled with the topographic complexity of the landscape and the operational constraints in applying fire, poses a conundrum for land managers in the Southern Appalachians.

Burning too hot—Burning too hot (high-intensity or dry-season burning) may reduce high levels of fuels and establish pine regeneration, but will typically produce undesirable levels of overstory mortality, which, in turn, will increase forest fuel loading, decrease the oldest structural components in the stand, exacerbate the loss of seed trees, increase the growth of undesirable hardwood resprouts through overstory release, and facilitate the invasion of nonnative plant species.

Burning too cool—Burning too cool (low-intensity or dormant-season burning) may avoid some of the negative effects of high-intensity burning, but could produce less-than-desired fire spread, fuel reduction, and reductions in fire-sensitive trees and shrubs. As a result, restoration objectives such as pine regeneration may not be met in a timely fashion, especially while seed trees continue to diminish across the landscape.

A fire restoration strategy

What, then, is the best course of action for reintroducing fire into long-unburned sites to restore oak and pine communities in the Southern Appalachians? Because the consequences of burning too hot are far more difficult to overcome than the consequences of burning too cool, we believe the most cautious approach is to begin with cool, dormant-season burns, and to gradually increase burn severity by varying burn season and fire intensity. Our experience in the Great Smoky Mountains has led us to a multiple-burn strategy with the following features:

- Frequent burning (2- to 7-year intervals) over a 20-year period.
- Gradual reduction of heavier fuels such as duff and coarse woody debris.
- First- and second-entry burns that are primarily low intensity (flame length <3 feet) and occur in the dormant or very early growing season. The goal for first- and second-entry burns is to avoid creating stand-level (>2 acre) canopy gaps that increase fuel loads and release fire-sensitive resprouts. This is most important during first entry.
- Subsequent burns that increasingly use variable intensity and seasonality to reduce fuels and achieve desired community structure and composition.
- Some form of monitoring that can be the basis for adaptive management. Monitoring can include simple visual assessments, burn severity maps, or various types of plots.

Restoring fire to long-unburned sites is a long-term process that will require the insight of fire researchers, as well as the experience and skill of fire managers. The strategy outlined above is, at best, an informal consensus, and may not be applicable to the broad range of regional fire management objectives or site-specific conditions. Additionally, this management approach does not consider the use of mechanical treatments, which may contribute to the rapid creation of desired forest structure, but which are typically limited to small-scale projects. Rather, this strategy constitutes a general set of guidelines that should allow managers to achieve long-term vegetation and fuels objectives across broad landscapes while avoiding negative outcomes. The most important principles embedded in this strategy are the reliance on moderation, patience, and adaptive management in the application of varied combinations of fire intensity and seasonality to meet regional goals for fuels management and pine/oak restoration.

Introduction to Individual Park Reports

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

- an update on fire effects monitoring and fire ecology activities
- review of 2014 prescribed burns
- analysis of long-term fire-effects monitoring data

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 into the long-term analyses, but are summarized in the review of last's years prescribed burns. As always, park resource and fire managers are encouraged to address any additional fire-effects questions or needs to the Fire Ecologist or Lead Monitor.

For parks that don't have an updated analysis of long-term data, more attention has been given to the review of the past year's projects or additional data analyses. The information gained from the project reviews is often more valuable for making management decisions in the near term, and these reviews are the most valuable part of this annual report for stimulating adaptive management discussions. These reports may be of interest to a wide range of readers, and we encourage folks to read what is being learned in parks other than their own: Most of these lessons are widely applicable. ***Highlights include:***

- *Products depicting the Presettlement Fire Regime and Vegetation at BISO (pp.16-17) provide suggestions for how Dr. Frost's research can be used for planning and evaluation*
- *Key points from the 2014 prescribed burn at CONG illustrate how fire effects monitoring can be used to improve future restoration burns (p. 42)*
- *Review of long-term monitoring of Dark Ridge at CUGA offers some perspective on changing fuel types following moderate to high severity burns in Appalachia (pp.49-50)*
- *The Dark Ridge results also include some of the best oak regeneration that we've seen in any park – some thoughts on the achievement of this important objective are also discussed (pp. 50-51).*

The fire effects team has spent a lot of time and effort over the past several years developing and implementing a variety of monitoring methods that have greatly enhanced our ability to provide more immediate and scientifically accurate feedback to managers about their prescribed burn programs and the most recent burns. Any comments, data requests, or feedback are always welcome.

Big South Fork National River and Recreation Area (BISO): 2014 Fire Effects Monitoring Annual Report

Activity Summary

The Fire-Effects team made two trips to Big South Fork during 2014. In addition to participating in the prescribed burn at Mitchell Field, the crew conducted long-term vegetation and fuels monitoring at the Darrow Ridge prescribed-burn site. In addition to the long-term monitoring plot work, the crew also conducted ground-truthing of multi-burn severity maps at Darrow Ridge. The Mitchell Field burn is described in the “Review of 2014 Projects” section of this report.

Finally, throughout field monitoring operations at Darrow Ridge, the crew also critically evaluated the condition of vegetation and fuels and developed several recommendations for ignition strategies that can help make the FY15 burn of Darrow Ridge a success. This knowledge of the current conditions within the burn unit, and the need to monitor the prescribed burn, makes it imperative that member(s) of the fire effects monitoring team are involved in burn operations at Darrow Ridge. Several of our recommendations have already been discussed with the Cumberland Gap Wildland Fire Module.

Additional fire ecology highlights for BISO during 2014 include completion of database construction for the “Presettlement Vegetation and Fire Regimes Mapping” project. The data collection and analysis was done by Dr. Cecil Frost during 2013, and his maps were digitally summarized into a static map by staff at BISO. The final steps to optimize the value of Dr. Frost’s data (i.e. build a database that is fully interactive in a GIS environment) were completed by our fire effects team during 2014. The data can now be used to make highly site-specific maps of presettlement vegetation and fire regimes. Examples were created for the Darrow Ridge fire-restoration site, and those maps are also featured in the “Review of 2014 Projects” section of this report.

Program Goals and Objectives

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

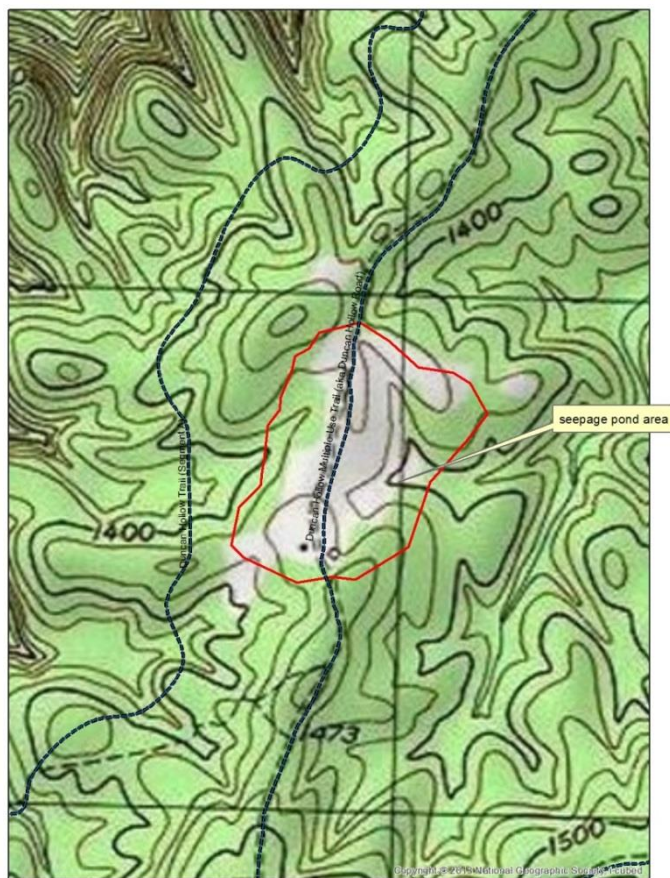
In past years’ reports, we’ve used this space to communicate existing goals and objectives and to improve the objectives as new data have become available. There are no significant changes in goals and objectives for BISO, so in the interest of not being repetitive, the reader is referred to the 2011 report. A listing of long-term objectives can be found in **Table 2**.

Review of 2014 Projects

Mitchell Fields Prescribed Burn:

The Mitchell Fields is an approximately 40 acre grass/woods unit located northeast of the Bandy Creek campground divided in half by Duncan Hollow Road (please see map). The Laurel Fork Creek is to the West and Northwest and various roads and trails border the wood-line on the additional sides. For the most part, the unit topography is along a broad flat ridge with occasional drainages typical of the Cumberland Plateau.

BISO Mitchell Fields Rx Burn 2014



The vegetation is mostly open fields dominated by mixed native warm-season grasses surrounded by forests typical of the Cumberland Plateau such as a variety of Oak species, red maple and black gum. Within the unit, pockets of weedier-type vegetation occurred such as historic-home site relics. Cursory talks with the Resource Management staff indicate that previous plantings of native grass species for seed collection purposes were carried out on site. One fairly interesting vegetation/landform type exists in the Eastern-center part of the unit is a remnant seepage bog. The bog-type area transitioned from the open grassland into the woodlands towards an old farm pond. Although this field is occasionally mowed and the quality of the bog vegetation was unassessed, the landform type and soils were noted.

Past burn occurred potentially in 1995-1996 and definitely in 2005(Spring and Fall), 2007, 2008 and then finally on March 26th 2014. One difference with this event, not considering the delayed start to the prescribed fire season, was that it only included the field, and excluded any forest vegetation. That being said, considerable preparation to exclude wooded areas needed to be done and decreased the size of the actual burn unit to 19 acres.



The treatment was a straightforward ring-type fire starting with the downwind side of the unit and working around flanks until the downwind sections were secure and head-fire could consume the remainder of fuels. This is essentially what happened except for several scattered fire whirls pushing fire across the line allowing for very small slop-over fires which were extinguished quickly.

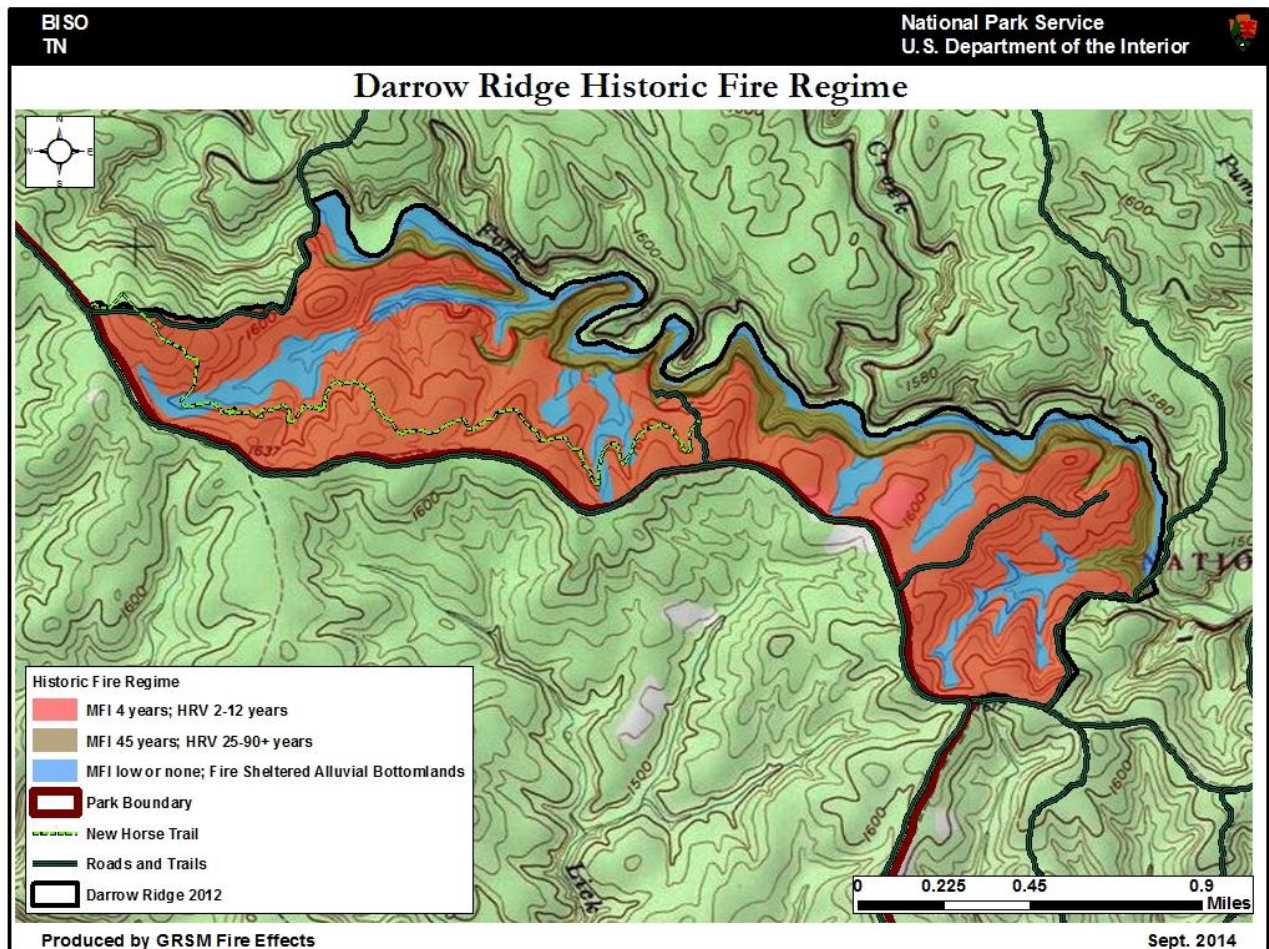
In general, the light FM 03 fuels were consumed 100% over 100% of the target area. The execution of this burn only took upwards of 1-2 hours. Fire behavior could be characterized in the above photograph moving rapidly across the unit. Overall, the burn was successful at achieving the objectives and should contribute to the restoration of native grasses in the Big South Fork National River and Recreation Area

Development of “Presettlement Vegetation and Fire Regimes” Spatial Products:

The report for this NPS Fire-funded study was completed by Dr. Cecil Frost in 2013, and was summarized in the 2013 annual report. Aside from the report, the spatial data from this project are of tremendous potential value to managers at BISO. As final products from that study, we received digitized mapping-units of the spatial components needed to construct the park-wide map contained in the report, though these spatial data were not organized into a database format. Several additional steps were required to “translate” these mapping units into clearly identifiable and scalable polygons of historic vegetation and historic fire regime. These steps were completed by our fire effects team during 2014. The data can now be used to make highly site-specific maps of presettlement vegetation and fire regimes (**Figures 1 and 2**). Once evaluated

for quality assurance, the historic vegetation patterns and fire regimes can also be used to inform management decision-making at a range of possible scales.

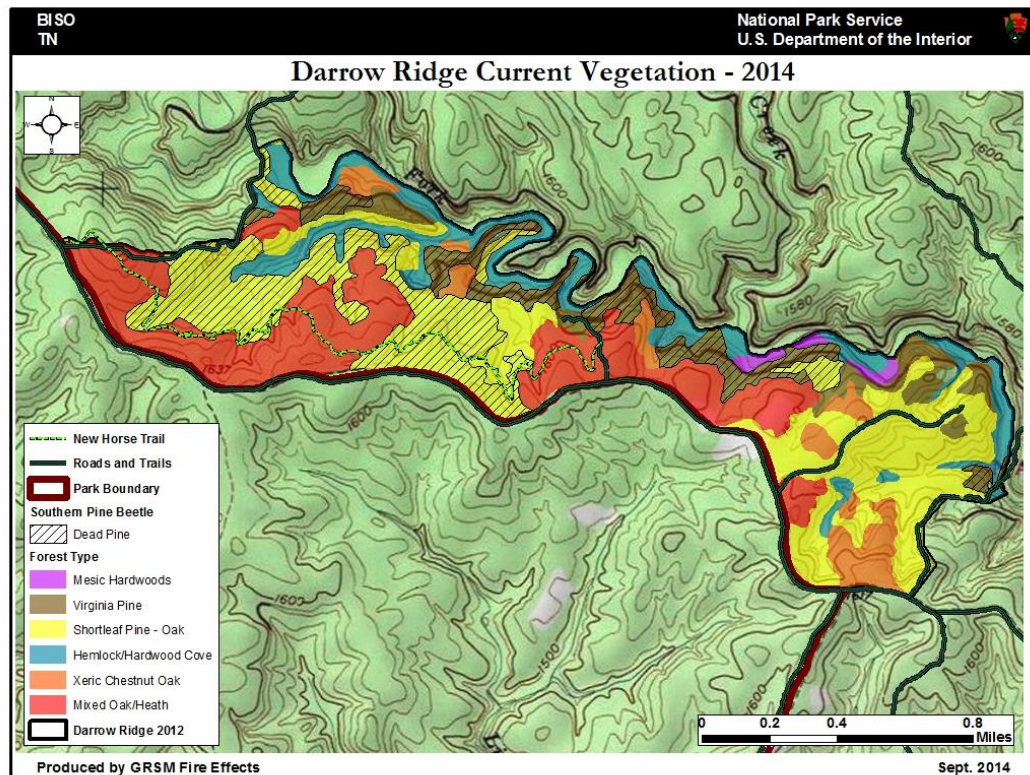
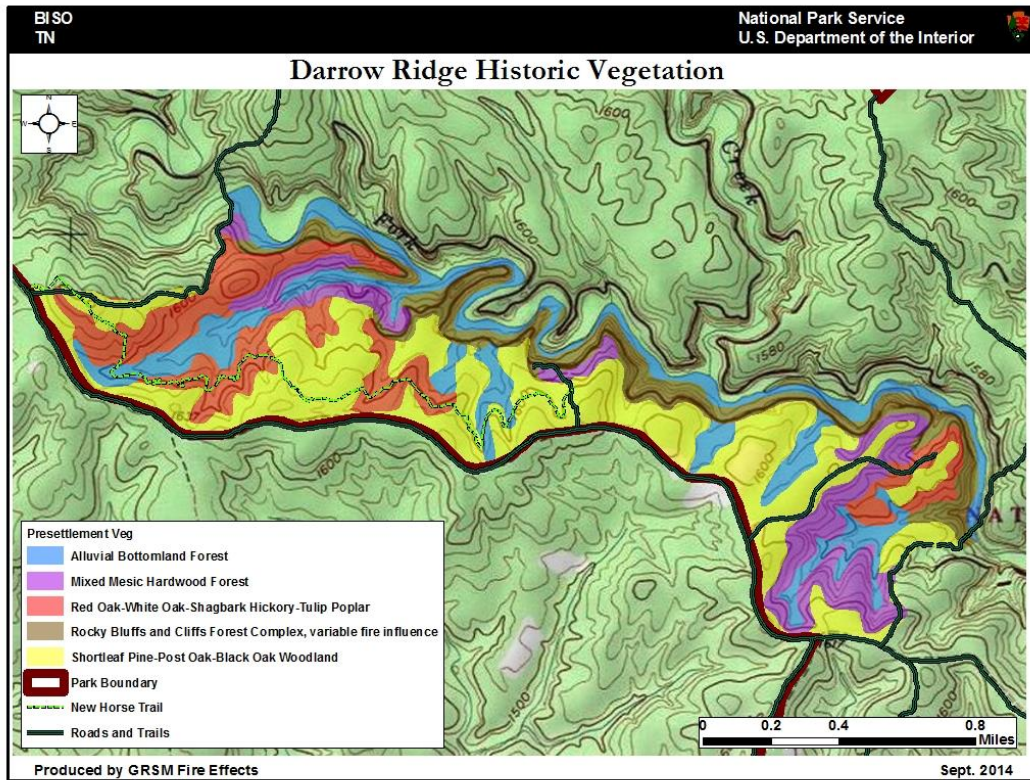
Figure 1. Modelled Historic Fire Regime for Darrow Ridge Prescribed Burn Unit.



The historic fire regime model (**Figure 1**) suggests that a high percentage of the Darrow Ridge prescribed burn unit experienced frequent fires prior to European settlement. The historic mean fire interval (**MFI**) is estimated to have been 4 years and the historic range of variation (**HRV**) is estimated to be between 2-12 years. This regime was the most frequent of those mapped by Dr. Frost within the modern-day boundaries of BISO. More sheltered sites, such as along creeks and bluffs, are depicted as burning only infrequently or not at all, which matches pretty well with our observations of fire behavior even today.

The historic vegetation model depicts a landscape dominated by shortleaf pine and oak woodlands, which has important compositional similarities to the current vegetation (**Figure 2**), but which differs tremendously in structure and implied dynamics. Such comparisons of historic and current vegetation may be useful for determining management goals and building funding proposals for forest restoration at BISO.

Figure 2. Comparison of Modelled Historic Vegetation and Current Vegetation.



Long Term Monitoring Results

There are no new data to add to the long-term monitoring results. The most up-to-date analysis of monitoring results is provided in **Table 1**.

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

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

Conclusion

This year's report documents ongoing fire effects monitoring efforts at BISO, which include burn severity mapping and pre-burn planning at Darrow Ridge, monitoring of the Mitchell Field prescribed burn, and development of spatial products from the Presettlement Vegetation and Fire Regimes work of Dr. Cecil Frost. The fire effects program is engaged in planning efforts for the upcoming Darrow Ridge prescribed burn, and will continue to collect and provide information to help make long-term restoration of that site a success.

Blue Ridge Parkway (BLRI): 2014 Fire Effects Monitoring Annual Report

Activity Summary

The fire effects crew conducted no monitoring activities at BLRI during 2014. This reflects the lack of prescribed burning during 2014, and uncertainty about the likelihood of projects in 2015. Communication with interagency partners indicates that the Brinegar Cabin/Doughton Park burn will not occur this year, but discussions about this burn will continue during 2015. Fire effects monitoring at BLRI will be a high priority in the coming year if that or another landscape-scale burn is planned for 2016 on Parkway land.

Program Goals and Objectives

The following goals and objectives constitute the general aims for the BLRI prescribed fire program. They provide broad guidelines for achieving restoration over multiple burns, and single-burn objectives that are complementary to achieving the long-term goals. As the prescribed burning program begins at BLRI, it is a great time to review the goals and restoration strategy, as well as the short-term and long-term objectives that will help to achieve those goals.

It is crucial for Park managers and SER Fire Staff to understand that these goals, strategies, and objectives, while not perfect, have been developed over many years with the benefit of abundant experience and monitoring data from similar forest types in several different NPS units. It is important to note that there remain some inconsistencies between the objectives listed below and those found in the *Doughton Park Prescribed Burn Plan*, particularly with respect to desired mortality of overstory trees following first-entry burns. Specific burn objectives should be reviewed and approved by park Resource Managers before each burn.

It is also 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 fuel 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.

Strategy - Use a series (3-5) of low to low-moderate severity prescribed burns to *gradually* reduce woody stem densities in all strata and reduce total fuel loading (see long term objectives); producing the variety of conditions that are favorable for regeneration of yellow pines, dry-site oaks, native herbaceous species and low-growing shrubs. **Minimize initial mortality** of mature yellow pines and oaks and prevent exotic plant invasions during first and second-entry burns by utilizing low-intensity/low-severity fires. Subsequent burns may increasingly use variable intensity and seasonality to achieve desired structure, fuel reduction, and composition. Fire-effects monitoring will be the basis for an adaptive-management approach to restoration. Monitoring can include simple visual assessments, burn severity maps, or various types of plots.

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 >50% 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
- Limit the mortality of mature oak and yellow pine to <10%
- 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-March through late 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.

Review of 2014 Projects

There were no projects completed during 2014.

Long Term Monitoring Results

No long-term data are available.

Conclusion

No fire effects monitoring occurred at BLRI in 2014, and monitoring efforts in the coming year will depend largely upon planning and funding for projects in fiscal year 2016. The fire effects crew will continue to work with USFS staff from the Grandfather R.D. to cooperatively monitor effects of USFS burning on and near BLRI.

Cape Hatteras National Seashore (CAHA): 2014 Fire Effects Monitoring Annual Report

Activity Summary

The fire effects crew was represented by Wylie Paxton during the Bodie Island 1.2/1.3 prescribed burns of 2014. Wylie acted as Fire Effects Monitor (FEMO) during and immediately after the burns, allowing our program to remain engaged in burning and monitoring operations at the Seashore. An overview of those burns is provided in the “Review of 2014 Projects” portion of this report.

During the 2012 monitoring trip to CAHA, 12 photo-plots were installed in Unit 1.3. Following the burn, these photo-plots were revisited during the summer of 2014 by CAHA Resource Management staff, allowing us to provide an interesting photo-journal of some of the effects of the burn. This journal is also included in the 2014 “Review” section of this report. Plans for 2015 include participating as FEMO on this year’s burns, and conducting a monitoring trip during late summer or fall to more fully assess fire effects from prescribed burning.

Program Goals and Objectives

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

Resource Goals

1. Reduce encroaching brush species from marsh habitats.
2. Reduce dead vegetation content of marsh grasses to improve marsh habitat for waterfowl and wading birds.
3. Maintain or improve herbaceous species diversity and cover in marsh and forested plant communities.
4. Maintain or improve shrub scrub habitat for resident and migratory avian species.
5. Maintain Mixed Maritime Forest to provide for quality wildlife habitat and visitor experiences.

Prescribed Fire Objectives

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

Review of 2014 Projects

Bodie Island units 1-2 and 1-3 (2060 acres):



The Bodie Island units are located South of Highway 264 and Nags Head, NC and Highway 12 to the East, with the Roanoke sound to the West. The Southern border is the “Navy Tower Road” that is used by park staff and to access communication towers and shooting range. Vegetation is a mix of brackish marsh along the sound side to tidally-influenced freshwater marsh on the interior. Large interior tidally-influenced freshwater ponds scattered throughout with high numbers of waterfowl occupancy during the winter and breeding season. The continuation of the interior dune heather community extends in broken sections almost entirely through both units.

Usually timing the burns for Bodie Island Units require a January or February time frame to utilize the prevalence of the North winds, but due to budgetary constraints at the beginning of the



Rx fire season; this burn happened on April 16, 2014. That was probably the last Northeast wind that would prevail before the onslaught of tourist arrivals, making burning along Highway 12 impossible. Hand ignition began on the South end along Navy tower road and securing the southern line before the Fish and Wildlife Marsh Masters could begin Interior ignition. Once the line was secured, the route was variable for Marsh Masters but inevitably headed Northward through both units as seen in the map below.



Fire was brought north along the road edge of Highway 12 and consumption varied from the sound to the corner of Highway 12.



Marsh Master securing South Line along "Navy Tower Road". Fuels burned in a mosaic pattern here where wetter marsh areas did not burn at all and higher marsh/Shrub areas saw moderate severity

In the photo series below, Highway 12 black-line operations produced dramatic display for visitors and varied Fire effects along the roadside and into the marsh.



ATV ignition with aligned winds adjacent to Highway 12 produced dramatic results

Figure 1: Hwy. 12 black-line operations Unit 1.3



In general, Photo above depicts the typical fire behavior seen along the road corridor and in shrub/scrub habitat. With regards to objectives, the photo series for Figure 2 below depicts interior unit fire effects

The end of fire occurred at a drainage canal between the Units 1.1 and 1.2 fire break. USFWS staff widened these fire breaks with an agreement through SERO Fire Office. All prep work was done with USFWS staff prior to the burn using their own equipment. Below depicts a close-up of the equipment used to plan and implement these successful burns.



Prescribed Fire Objectives Achieved?

1. **Reduce hazardous fuel loading thru consumption of >70% of 1 hour fuels and >60% of 10 hour fuels within each burn unit.**

This is true in with respect to marsh and marsh-type habitat. Although the burn was a varied mosaic of burned and unburned, there was at least 70% of fine fuels consumed that would reduce the spread of fire with a diminishing effect of approximately 3 years. The shrub /scrub areas that did in fact burn may take longer to recover and be slightly less of a concern based on FEMO observations

2. **Reintroduce fire disturbance regime into all appropriate vegetative communities in the park.**

It is unclear at this time where natural fire played a part in this system and thus difficult to comment on, although fire may be useful in managing marsh habitat for broad objectives

3. **Top kill 50-75% woody brush vegetation in marsh habitats.**

As depicted in the photo series below, some shrub-scrub habitat was affected by fire and other places it was not. Based on plot information, it would appear at least 50% of the unit burned

4. **Reduce live and dead fuel loading by 50-80% in the shrub-scrub habitat.**

Without a clear delineation of this particular habitat type, it may be difficult to tell whether objectives were achieved throughout the unit. My assumption is the target community being Wax-myrtle/Saltmeadow cordgrass shrub-land being the specific classified vegetation to reduce. The entire western half of the unit is remnant dune and is most likely an intact vegetation community unrelated to fire and fire protection (fire spread low in this area) In other woody-dominated areas, the picture below depicts a clear result of reduction in fuel loading across the unit

Fire Effects Monitoring

The burns effects were varied, of course, achieving consumption of 1-10 fuels in parts of the unit to not burning in other parts as seen below. The following picture is a marsh area where water levels or may have been too high or vegetation to green for fire to carry across.



There was a mosaic of burned and unburned vegetation within the 1.3 burn unit.



More severe top-kill of shrub-type vegetation

In 2012, twelve photo-points with brief vegetation description were installed in unit 1.3. Unit 1.2 was not scheduled to burn at that time so no photo-points were installed. Each point had 4 photos associated with the point and species composition data collected. Out of those 12 plots, based on qualitative assessments each plot had at least some fire around them or burned completely.

The following photo series are comparisons of pre-burn and post burn monitoring. As depicted in **Figures 2-4**: the entire surrounding marsh appears to have burned completely as evidenced by the high to moderate top-kill of the shrub layer.

Figure 2: Post Burn Needle Rush High Marsh Shrub/Scrub habitat top-kill effects depicted in Photo series from Photo point 22



Fire-Effects Photo Point 25 Pre and Post images depict the widespread coverage of the burn, and indicate good success at meeting objectives for top-kill of woody brush. *Photos in the bottom series correspond to the photos that are in the same position in the top series.*

Figure 3 CAHA Photo Point 25 Pre October 2012

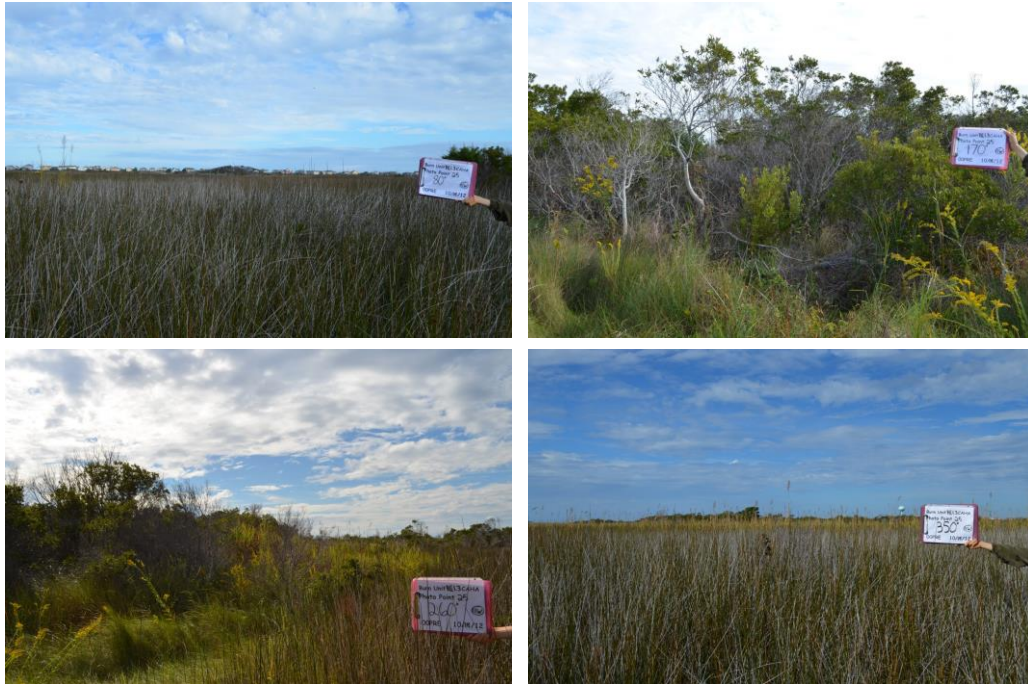


Figure 4 CAHA Photo Point 25 01Post June 2014

CAHA Photo Point 25 Unit 1.3 POST



The main concern with fire from the parks Resource Management staff is the spread of the invasive grass *Phragmites australis*. It is known to spread with the application of fire and ground disturbance. Of the 12 Photo points, 6 of those points had some amount of *Phragmites australis* associated with them. Each area burned with varying degree from not burning to completely burned, regardless of the fuels surrounding. Though no mapping of each one of the *Phragmites* stands has been completed, careful examination of the continued photo-series and resampling of the vegetation cover can help determine the effects on *Phragmites*. More extensive monitoring of these patches may be helpful prior to burning and 1-2 years following the burn.

Figure 5 *Phragmites australis* along Hwy. 12



The other highlight for the project was the level of combined effort from multiple agencies. The Fish and Wildlife Fire Staff, North Carolina State Forest Service , N.P.S. Southeast Regional staff, Cape Hatteras National Seashore staff, Cumberland Gap Wildland Fire module, Big South Fork National Recreation Area fire staff, Kings Mountain National Military Park fire staff and Great Smoky Mountains Fire Effects staff were combined to make this burn a success considering all the challenges. Considerable effort and flexibility went into the 2014 project season for Cape Hatteras National Seashore and the Cumberland Gap Wildland Fire Module.

Long Term Monitoring Results

As the monitoring program at CAHA just began in 2012, there are no long-term data to discuss. Short term results from the 2014 prescribed burns are provided in this year's report. As monitoring protocols are implemented over the course of several years, there should be results from photo-monitoring, species cover data, and burn severity mapping that can help determine if objectives are being met, and to ensure that negative outcomes are minimized. The current inventory of monitoring plots is:

Bodie Island Unit 1.3 – 12 plots w/ photopoints and dominant vegetation cover

Bodie Island Unit 1.4 – 12 photopoints

Bodie Island Unit 1.5 – 2 photopoints

Bodie Island Unit 1.8 – 3 plots w/ photopoints and dominant vegetation cover

Bodie Island Unit 1.8 – 4 Wildland-Urban-Interface photopoints.

Conclusion

Burn-day and photo-point monitoring are beginning to provide good documentation for patterns of fire spread and the ability of these burns to effectively top-kill woody vegetation. The monitoring work completed by resource managers at CAHA is integral to the success of our monitoring program at the Seashore. Additional monitoring during the growing season is needed to more fully address issues of compositional change, in particular the effects of fire on populations of *Phragmites australis*. Accordingly, plans for the 2015 monitoring season include a trip to CAHA to provide a more in-depth evaluation of prescribed burning efforts to date. Such a trip is likely to occur in late September or early October.

Congaree National Park (CONG): 2014 Fire Effects Monitoring Annual Report

Activity Summary

The fire effects monitoring crew made three visits to CONG in 2014. In May, the crew was joined by fire effects staff from Natchez Trace for the prescribed burns of Harry Hampton, RCW, Red Bluff, and Dawson's Cabin, providing FEMO services during the burn and immediate postburn monitoring of these exciting growing-season burns.

The entire fire ecology/fire effects staff conducted an extended monitoring trip in July to do long-term plot monitoring and landscape severity monitoring. During the July trip, the crew also conducted pre-treatment monitoring for a mechanical tree-thinning project scheduled for 2016. Finally, members made a brief visit in December to identify unknown plant species and assess the effects of a separate tree-thinning project completed by CUGA WFM.

The July monitoring trip was particularly successful, resulting in a wealth of monitoring data, discovery of a previously unknown grassy woodland site, and important recommendations for future burns and mechanical projects. A more detailed account of our activities can be found in the "Review of 2014 Projects."

Program Goals and Objectives

In past years' reports, we've used this space to communicate existing goals and objectives and to improve the objectives as new data have become available. The only potential change to the existing objectives may pertain to the protection of sensitive hardwoods and old-growth loblolly pines that are found in the bluff and along the edge of the floodplain forest; however, the actual objectives to reflect these resource values have not been fully discussed or finalized. Other objectives to possibly be determined in the coming year pertain to the mechanical tree removal being planned for parts of the Park. Past and future monitoring efforts should help guide the development of appropriate objectives.

Until such time as the objectives are updated, the reader is referred to the 2011 Annual Report for a review of the prescribed fire objectives at Congaree. Long-term objectives are summarized in **Table 1**.

Review of 2014 Projects

Harry Hampton, RCW, Red Bluff, and Dawson's Cabin Prescribed Burns:

Congaree Rx Burn Units

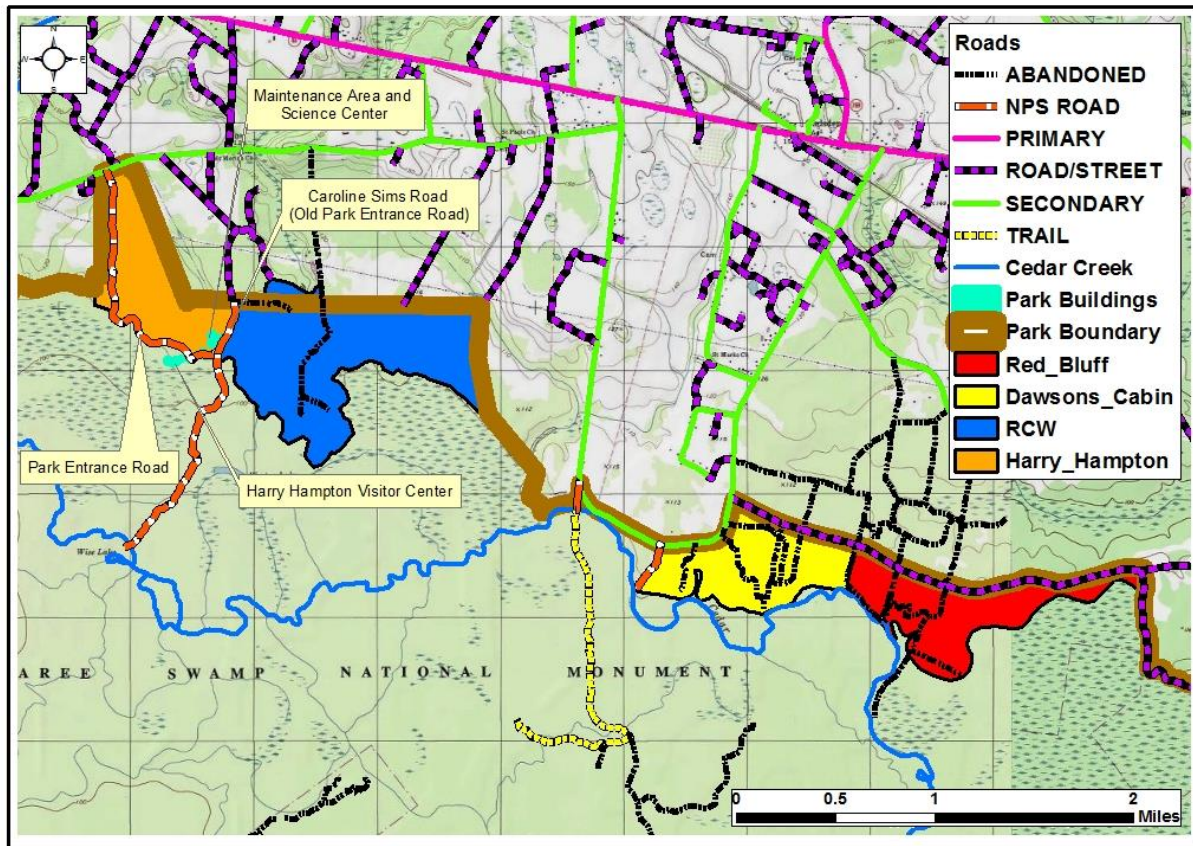


Figure 1. Map detailing location and arrangement of the 2014 Congaree prescribed burn units.

The bulk of the CONG prescribed burn program is comprised by 4 burn units totaling roughly 1000 acres. The Harry Hampton VC unit runs along a portion of the northern boundary of CONG and encompasses the park entrance road and primary park infrastructure (VC, Maintenance Area, Science Center, etc.) Overstory vegetation in this area is dominated by mature successional and plantation loblolly pine (*Pinus taeda*) with small stands of drier post oak (*Quercus stellata*) and shortleaf pine (*Pinus echinata*) and scattered depressions containing willow oak (*Quercus phellos*) and water oak (*Quercus nigra*). The adjacent RCW unit is located just east of the Harry Hampton, separated by the old park entrance road (Caroline Sims Road), and it forms the basis for the CONG burn program as it contains a large area of remnant longleaf pine woodland formerly used by Red-cockaded Woodpeckers (hence the burn unit name 'RCW') with a significant diverse herbaceous layer. The southern portion of RCW transitions from upland pine down a gradual "bluff" into floodplain forest containing bottomland oak, scattered large loblolly pine, and depressions with bald-cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*). Just east of these units, also running along the northern park boundary, are the Dawson's Cabin and adjacent Red Bluff units. These units

contain mature plantation loblolly pine stands along with successional hardwoods, such as sweetgum (*Liquidambar styraciflua*) and water oak, intermixed with loblolly pine. Like RCW, these units are bounded by floodplain forest along their southern perimeter, however the transitional “bluff” tends to be more abrupt and steep and Cedar Creek, a prominent tributary of the Congaree River, runs almost directly along the bottom of the bluff for most of the length of the Dawson’s Cabin unit.

The core longleaf pine stand in RCW unit has been the primary focus of the CONG prescribed burn with this year being the 8th burn under NPS management and the 12th known burn in recent history, based on records going back to the early 1980’s. The Harry Hampton unit was first burned in 2002, essentially as an addition to the RCW unit, and this has remained the case for all subsequent burns making 2014 the 6th entry. Dawson’s Cabin and Red Bluff have always been burned as a single joined unit, and this year marks their 4th burn entry.

The previous 2012 burn season was notable for 4 major reasons:

1. It was the first year that all 4 burn units were treated in the same season
2. Fire burned in a very continuous pattern across all 4 units with excellent consumption of litter and cured grass fuels, generally top-killing hardwood seedlings (esp. sweetgum) and shrubs <2-3 m tall.
3. Prior to 2012, RCW experienced a 4 year break between burns and at least 6 years since the last burn that provided any significant coverage and top-kill of sweetgum seedlings.
4. 1000-hr+ fuels, especially yellow pine, were dry and available due to a long term drying trend which allowed the fire to hold over for several consecutive days in RCW unit and thereby move much further into the floodplain than in most previous years and even burn down a few large live loblolly trees with pre-existing basal wounds.

This year’s burns nearly matched the coverage of the 2012 burns, but given the shorter 2 year interval since the last burn, the early growing season timing, and the relatively dry conditions the resulting severity was more profound.

Harry Hampton and RCW

The Harry Hampton and RCW units were burned in 2 simultaneous operations on May 6, 2014 under full leaf-on conditions. Significant moisture recovery occurred during 2013 from a long term drying trend in 2012 and prior years. While general moisture levels were closer to normal, short term conditions immediately preceding the burn were relatively dry. Relative humidity prior to and during the burn was in the low 30s and high 20s. Coverage of fire was excellent, but without the same long term persistence observed in RCW during 2012. General moisture levels in the floodplain and more specifically moisture of heavy fuels were much closer to normal. Ultimately, fire traveled only a short distance into the floodplain and went out within the first 24-48 hrs of ignition except for on a single low ridge of planted loblolly pine where the

continuous fuel bed of pine needles allowed fire to slowly back and flank for a few days. However, no felling of large live loblolly trees was observed, especially since fire did not travel far enough to reach these individuals. **Figure 2** shows a comparison of the extent of fire in the floodplain between the 2012 and 2014 burns.

RCW Floodplain Fire Extent: 2012 vs. 2014 Rx Burn

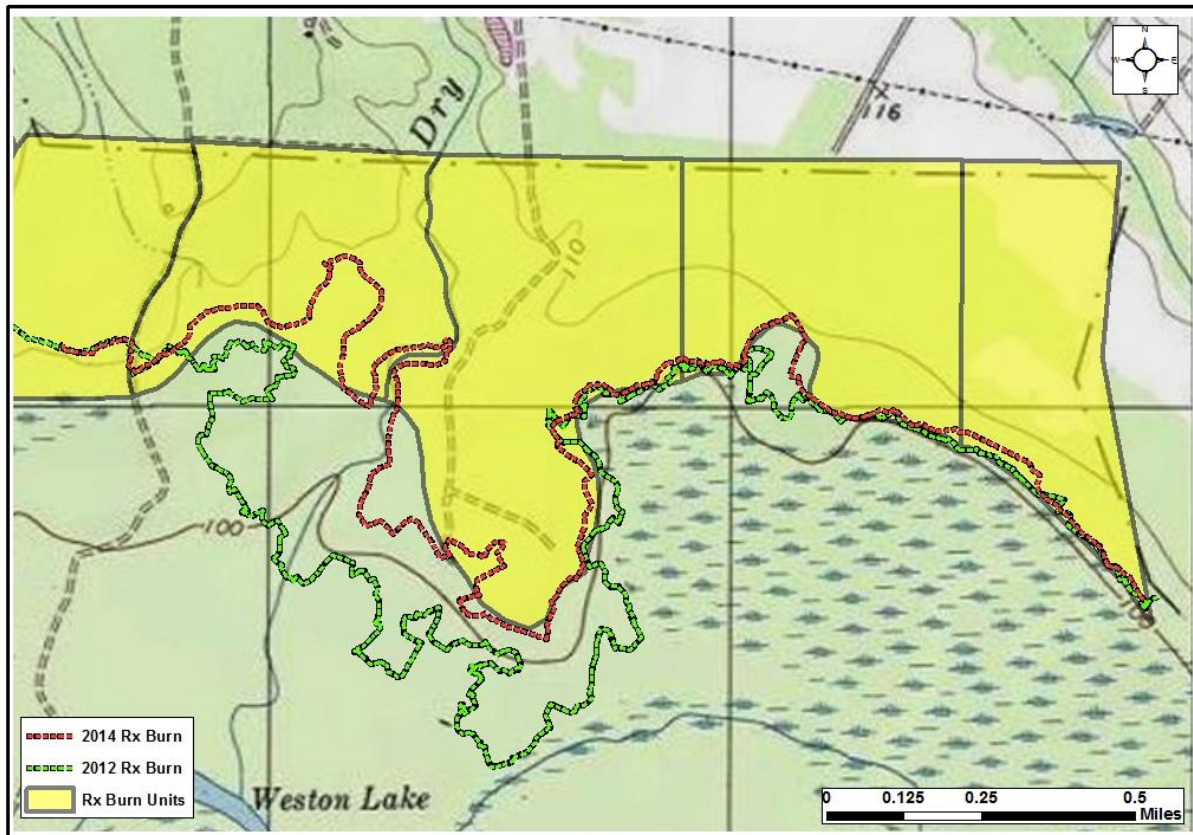


Figure 2. Comparison of the extent of fire in the RCW floodplain between the 2012 and 2014 prescribed burns.

General post burn reconnaissance both immediately following the burn and later in early July, indicate overall low-moderate severity with significant top-kill of tree seedlings, shrubs, and some small diameter poles along with a few individuals or small groups of overstory mortality. Reducing encroachment of hardwood saplings in the understory, specifically sweetgum, is one of the key objectives for these units that appears to have been achieved with this burn, even more so compared to the 2012 entry. **Tables 1** and **2** clearly demonstrate the downward trend in sweetgum sapling density for RCW and Harry Hampton respectively.

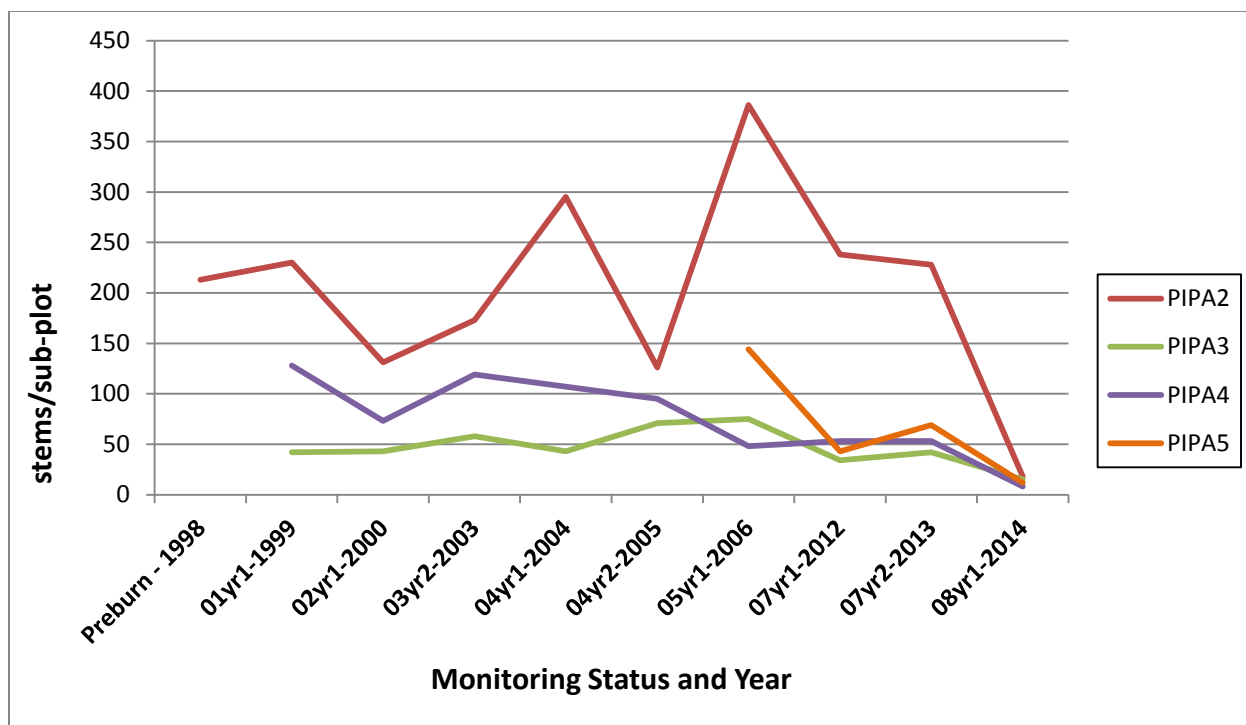


Table 1. Sweet-gum sapling density for RCW plots. For stems taller than 0.6m (2 ft).

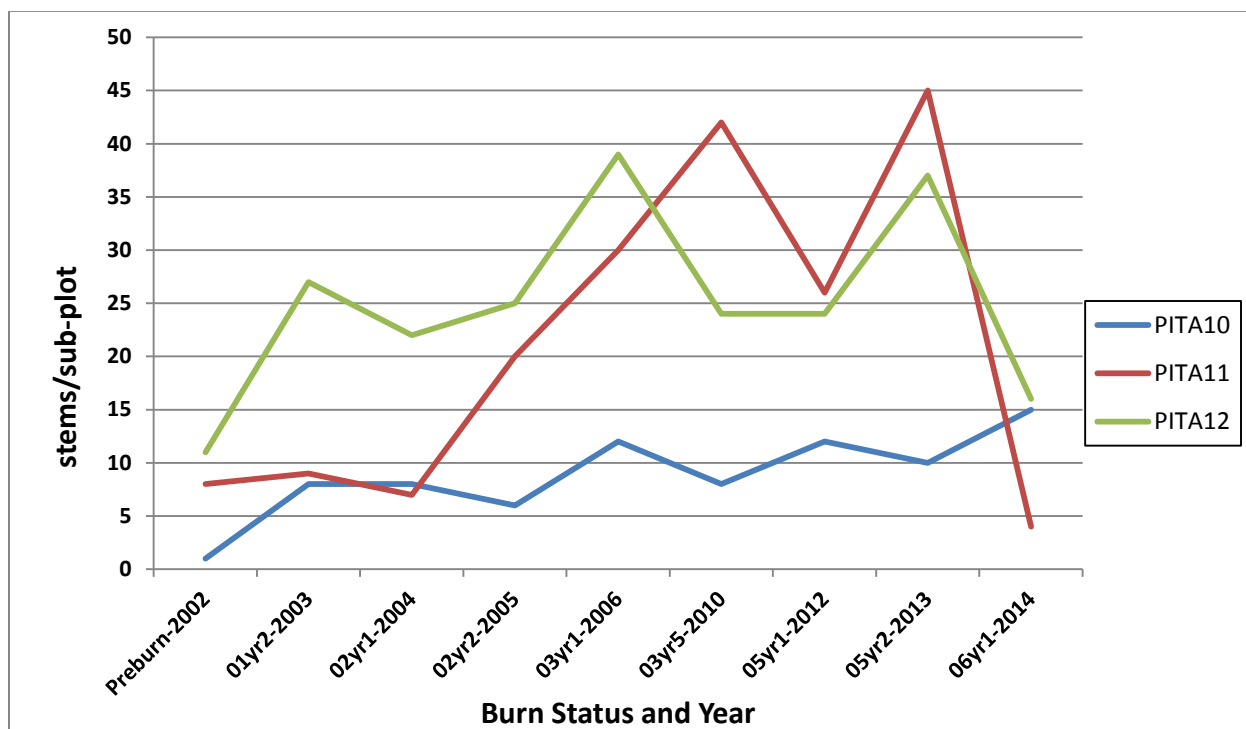


Table 2. Sweet-gum sapling density for Harry Hampton VC plots. For stems taller than 0.6m (2 ft).

Overstory cover (mostly loblolly pine), was largely unchanged despite some areas of significant canopy scorch. These areas included the core longleaf pine area in RCW, and scattered patches throughout Harry Hampton along with one significant patch just south of the powerline corridor which contained a large stand of pole size loblolly pine that was thinned but generally recovered from the heavy scorch. The most notable area of exception was to the east of the old park entrance road across from and slightly north of the science center where the road and the park boundary form a sharp corner. This area was one of the last spots ignited in the RCW unit during the hottest, driest part of the day. Moreover, it was essentially boxed in with fire when an interior campsite was burned around for protection then firing proceeded to light along the boundary and down the road, creating an upside down 'U' shaped pattern that allowed fire to pull together with great intensity (**Photo 1 and 2**).



Photo 1. Ignition of northwest corner of RCW. Notice distant fire interior around the campground. Photo was taken near the northwest corner from the old park entrance road.

Photo 2. Fire rapidly pulling in off the old park entrance road. Photo was taken looking north toward the northwest corner of RCW.



This area experienced close to 100% scorch and severe char of the overstory loblolly and scattered longleaf pines resulting in almost complete canopy removal allowing increased sunlight to the forest floor and facilitating a significant herbaceous response, especially grasses, which is discussed later in this section. Burn severity imagery requested through USGS, appears to match post burn mid-summer observations (**Figure 3**).

Harry Hampton VC and RCW 2014 Burn Severity

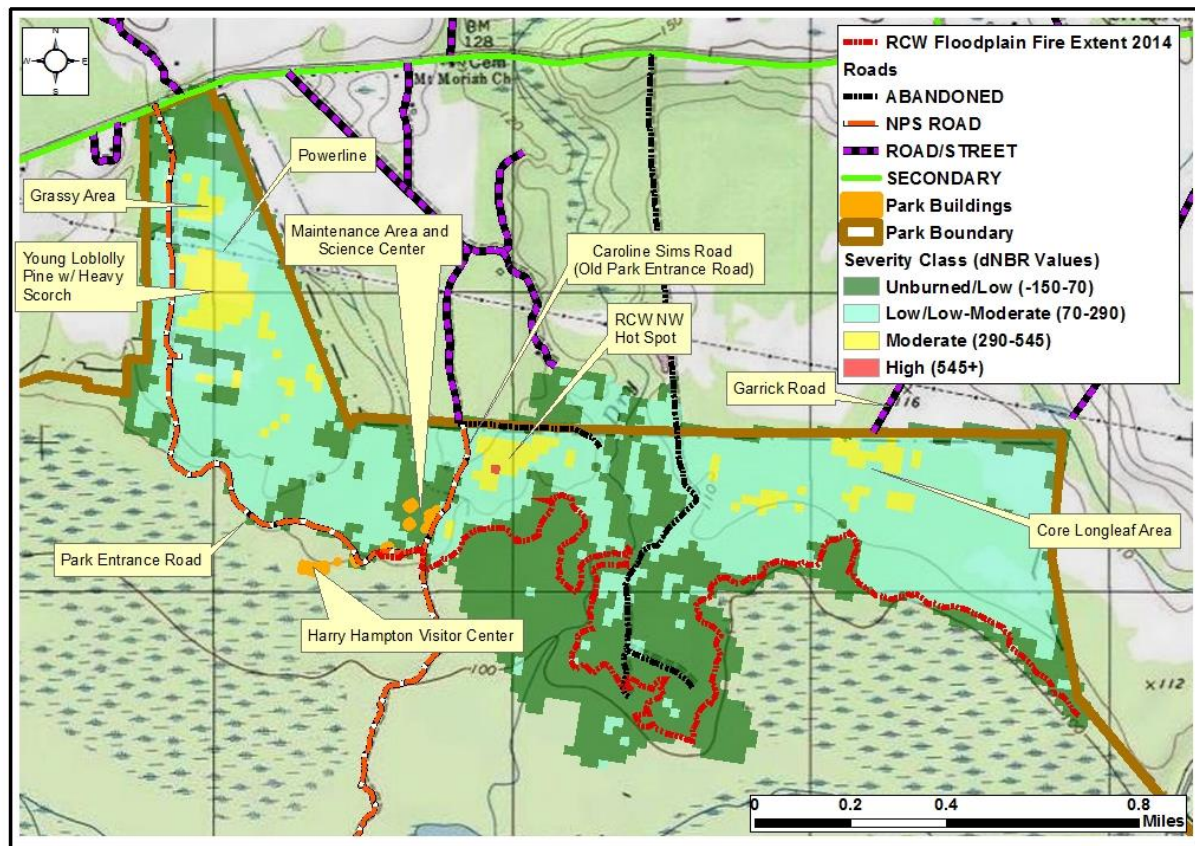


Figure 3. Burn severity image derived from pre and post burn Landsat satellite imagery.

As indicated in the severity image, the core section of longleaf pine burned with greater intensity than much of the surrounding uplands in RCW. Overstory longleaf pines in this area are more broadly scattered creating an open and exposed fuelbed containing cured grasses such as little bluestem (*Schizachyrium scoparium*) and silver plume grass (*Saccharum alopecuroides*), cured bracken fern (*Pteridium aquilinum*), and various low shrubs such as blueberries (*Vaccinium* spp.) in addition to pine needles. Hence, intensity was largely driven by this change in fuel type and exposure to sunlight. So, the observed severity was not only an indication of canopy scorch, but also included significant herbaceous layer effects which were more visible to the Landsat satellite in this area given the open woodland structure.

A few small scale canopy gaps have been created and/or expanded in the dense loblolly pine overstory of the Harry Hampton unit during the 2012 and 2014 burns, allowing scattered areas of increased sunlight. The most notable location is in the northern portion of Harry Hampton east of the entrance and north of the powerline corridor. During the summer monitoring trip, this area appeared to show an increased grass response, however, identification was not possible during that visit. So, a follow-up trip was made in early December to look at this area when fertile specimens of the grasses would be available and to scout both the core longleaf area and the hot spot in the northwest corner of RCW. The Harry Hampton site proved to be dense and rich with numerous grasses, most notably including little bluestem, broomsedge (*Andropogon virginicus*), Elliott's bluestem (*Andropogon elliottii*), splitbeard bluestem (*Andropogon ternarius*), Indian grass (*Sorghastrum nutans*), silver plume grass, deceptive bluestem (*Andropogon virginicus* var. *decipiens*), longleaf wood oats (*Chasmanthium sessiliflorum*), and wiregrass (*Aristida* sp.) (**Photo 3**).



Photo 3. GRSM Fire Ecologist Rob Klein standing on the edge of the grassy area in northern part of the Harry Hampton unit.

The canopy gap located in northwest corner of RCW showed a very similar grass response including little bluestem, silver plume grass, Indian grass, and to a lesser extent Elliott's bluestem, longleaf wood oats, and wiregrass (**Photo 4**).

Photo 4. Grass response observed in new canopy gap located in northwest corner of RCW.



This area should be interesting to track in the coming years given the promising grass response. Hopefully with continued burning the herbaceous species richness and cover density will be maintained if not increased, hardwood encroachment will be minimized, and longleaf pine seedlings will be favored as the replacement overstory given availability of adjacent seed trees. However, while this area shows great potential, it is advisable to give careful consideration to the use of ignition patterns that could lead to large scale canopy removal during a single burn event. This area has only a small handful of mature longleaf, which were heavily impacted by this and past burns. While the area overall represents strong restoration results, care needs to be taken with such few individual trees.

Grass response in the core longleaf area also appeared to be much increased compared to previous years with little bluestem, silver plume grass, and Indian grass commonly occurring. Additionally, retention of longleaf seedlings, especially taller individuals (>1-2m tall), was generally high (**Photo 5**).



Photo 5. Grass response and longleaf seedling survival in core longleaf pine area of RCW

Future monitoring will be required to determine if there is a true shift in dominance of grasses over other herbaceous species in this area, however it is obvious from past monitoring and observation that continued frequent burning is required to maintain the present herbaceous understory and control the ever present sweetgum sapling encroachment, not only in this core longleaf area, but throughout entire RCW and Harry Hampton units.

One final area of note is the narrow strip of forest along the west side of the park entrance road in the Harry Hampton unit. This area has been burn with fairly moderate to high intensity during both the 2012 and 2014 burns due to timing of ignition (afternoon) and ignition pattern (east and west boundaries both being ignited allowing fire to move across the narrow strip with great speed and intensity). The overstory in this strip is a mix of successional mature loblolly pine and depressions with large willow oak and water oak. While the previous treatment of this area has not removed any significant portion of the overstory, it has resulted in basal damage to some of the large fire sensitive willow and water oaks. Ignition technique and time of day should be carefully considered during future burns to avoid killing these large oaks and thereby creating large hazard trees adjacent to a roadway and the park boundary and to avoid increasing fuel loading.

Key Points for the RCW and Harry Hampton burns:

1. 2014 marks one of the most significant burns in the history of NPS ownership for this area due to the coverage of fire, impacts to understory sweetgum, overstory impacts, and grass response
2. Ignition patterns such as observed in the northwest corner of RCW should be used in a limited and well planned manner or avoided altogether due to the limited numbers of longleaf in that area.
3. The narrow strip of forest along the west side of the park entrance road should be burned with low intensity fire in the future to avoid the creation of hazard trees along the road or near the park boundary.
4. Given the combined effects of the 2012 and 2014 burns, both RCW and Harry Hampton are well positioned for future burns to expand upon the existing progress. Every effort should be made to burn on at least a 2-3 year rotation, if not more often for RCW, so that ground is not lost on controlling sweetgum encroachment, expanding the diverse herbaceous understory, and creating a more open pine woodland structure. Moreover, growing season burning should be considered as often as possible, although not at the expense of missing an opportunity to burn during a given year.

Dawson's Cabin and Red Bluff

Dawson's Cabin and Red Bluff were burned as one combined unit for the 4th time on May 7, 2014. Like the previous day's burn of RCW and Harry Hampton, conditions were sunny and dry with relative humidities in the 30's to upper 20's for most of the burning period. As with the 2012 burn, coverage of fire was fairly continuous across much of the upland portion of the unit, burning onto the bluff in many areas but rarely traveling into the floodplain. Ignition primarily consisted of firing along the roads forming the northern boundary of the units and allowing fire to back and flank interior toward the bluff. Given growing season conditions, fire easily top-killed most of the sweetgum seedlings growing under the long, wide strip of loblolly pine plantation forest adjacent to Red Bluff Road, a dirt road forming most of the northern boundary (**Photo 6**).



Photo 6. Example of fire backing and flanking through planted loblolly pine forest common to the Dawson's Cabin and Red Bluff units. Fire caused heavy scorch and basal damage to understory sweetgum seedlings.

Generally, the overstory loblolly pine remains intact after this 4th entry, but it has been thinned and occasional small gaps have been created, especially during the most recent 2012 and 2014 burns (**Figure 4**).

Dawson's Cabin and Red Bluff 2014 Burn Severity

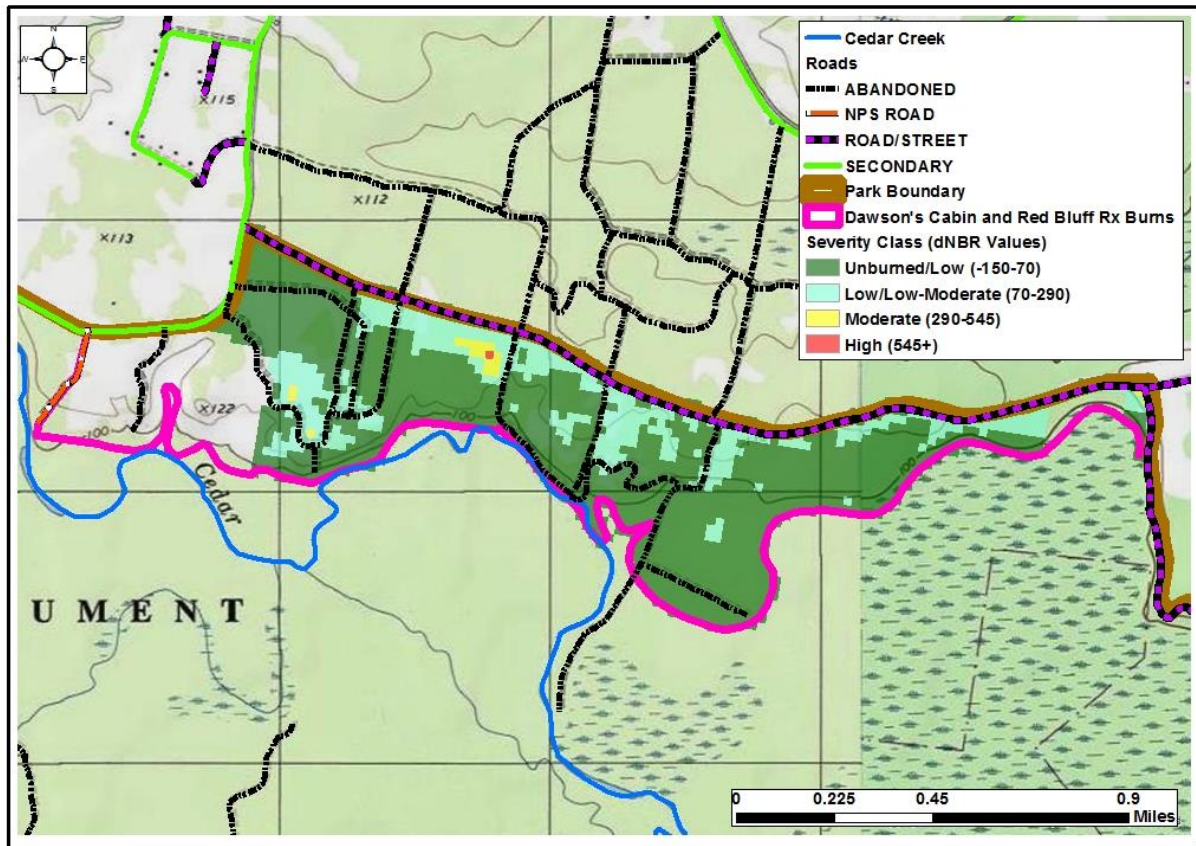


Figure 4. Severity map of Dawson's Cabin and Red Bluff burn units. Areas of missing data are due to cloud cover present in the Landsat satellite image.

The most notable area of severity occurred on the boundary of the 2 units in the northeast corner of Dawson's Cabin at the intersection of Red Bluff Road and an old abandoned road bed. Similar to the RCW unit, this location was essentially boxed in with fire, greatly increasing the intensity and resulting in a small canopy gap in the planted loblolly pine. Much of the uplands, however, burned in a uniform manner of low to low-moderate severity with occasional pockets of higher severity.

Given the lesser ecological significance of this area compared to RCW and Harry Hampton, both of which appear to have comparatively less soil disturbance and more significant herbaceous layers, only a brief amount of time was available for post burn monitoring of Red Bluff and Dawson's cabin. Some headway has been made toward thinning the dense loblolly overstory, but it is still far from resembling a pine woodland or savanna in structure. Moreover, wide spread invasion by the non-native wisteria (*Wisteria* sp.) and heavy soil disturbance from feral hog rooting has reduced the already limit herbaceous layer. A few patches of shortleaf pine and post oak have been observed in the Dawson's Cabin unit and a few individuals of longleaf pine have found, but this area is basically a heavily disturbed successional forest that has limited

potential to be 'restored' in any functional way using fire alone. However, some small areas of interesting composition and structure may present themselves as future burns continue to thin the dense overstory and expand small canopy gaps.

Harry Hampton Mechanical Project Monitoring:

In 2013, CONG was awarded project money through the NPS Servicewide Comprehensive Call (SCC) to use mechanical methods to restore upland pine communities along the entrance road to the Park Headquarters (**Figure 5**). The specific work outlined in the project proposal calls for mechanical reduction of trees that are < 6" in diameter using a low-impact Fecon tractor with a masticating head. The project is scheduled to be started and completed in summer of 2016.

The approved project includes a vegetation monitoring component, and the Appalachian fire effects crew was requested to develop and implement a monitoring plan for this project. Because the proposed project only broadly identifies a 100-acre area in the vicinity of the Park Headquarters, the first step to establish monitoring is to verify the exact areas where tree removal will occur. During the July 2014 monitoring trip, the crew spent one day completing a survey of the proposed project area, with the goals of: 1) determining the most suitable areas for tractor operation and tree thinning, 2) identifying areas within the project area that may be sensitive to tractor operation and tree thinning, 3) developing a map to convey recommendations to CONG managers the tractor operator, and 4) determine the sampling area in which to locate monitoring plots.

There are several products that have resulted from this field work (**Figure 5**):

- A map of the project area with sensitive areas and recommended sites for tree removal identified
- Photo-documentation and species list for a previously unknown grassy savanna with a rich understory dominated by native warm-season grasses (more details can be found in the review of the 2014 prescribed burns)
- A geodatabase containing all the pertinent natural, cultural, logistical (e.g. ditches), and structural items of interest within the project area
- Detailed geographic data for locations of every known Longleaf and Shortleaf pine tree in the project area.

Installation and pre-treatment vegetation monitoring for this project will be undertaken during the summers of 2015 and 2016.

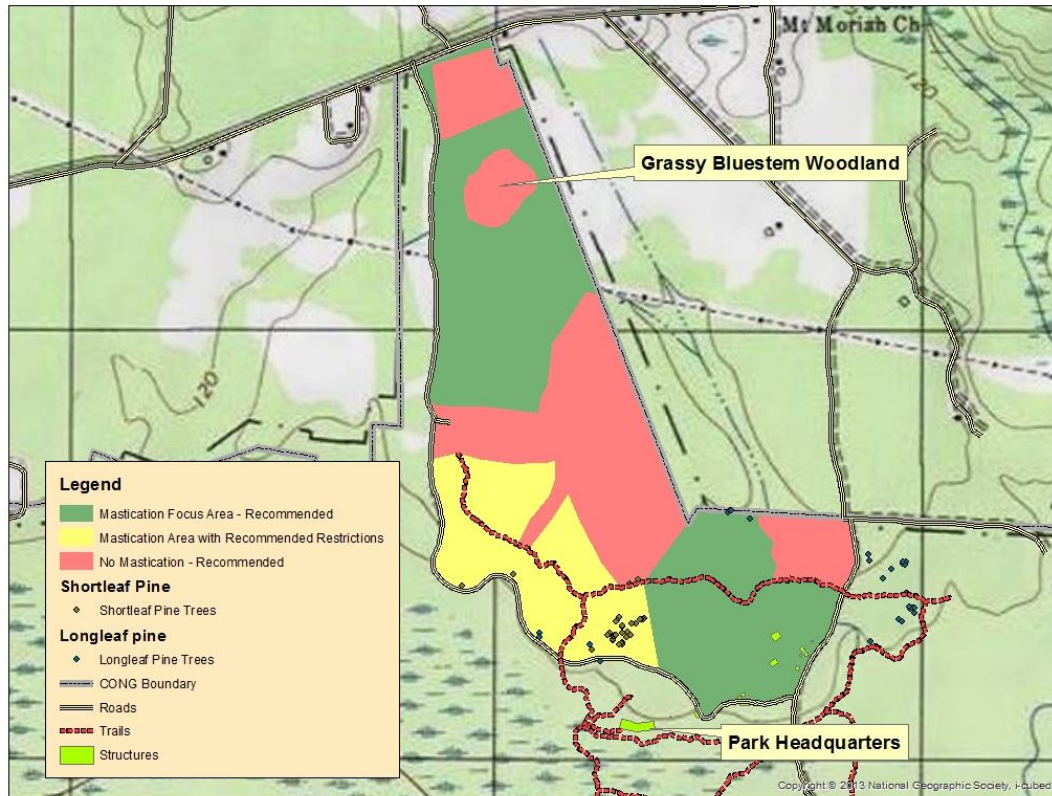


Figure 5. Planning Map for 2016 Mechanical Project

Long Term Monitoring Results

There has been no update to the standard analysis of long-term monitoring results. Consequently, **Table 1** has not been updated for this report, though we include it below as a reference point for reviewing the progress toward achieving program objectives. As noted in previous years, the results from CONG do not accurately represent the status and trends observed in the core longleaf area. However, the collective results are a good example of the trends in the more abundant loblolly pine forest type, and those results suggest that CONG is making reasonable progress in the long-term process of converting the dense loblolly forest into more of an open woodland structure characterized by lighter fuels.

Conclusion

2014 was a highly successful year for the prescribed fire program at Congaree. The park burned the vast majority of its burn unit acreage with a series of very effective growing season burn. There are a couple of things that can be improved upon, such as better planning of the tricky ignition at the corner near the Science Center or working to reduce the intensity in the oak – pine forest on the west side (narrow side) of the park entrance road – but overall these burns were very well done and produced great results in the understory and midstory. Specifically, a large percentage of sweetgum seedlings and poles were top-killed, and there was an outstanding response by native grasses and forbs.

Table 1. Objectives and long-term monitoring results for CONG

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% (<i>n=4 plots, 1 burn unit</i>)	No	2008
	15-30% Reduction in overstory tree density	Overstory reduction after 5 burns: 4% (<i>n=4 plots, 1 burn unit</i>)	No	2008
	>200 tall (>1m) Longleaf pine seedlings /ac	Preburn density: data not clean After 5 burns: 0 (<i>n=4 plots, 1 burn unit</i>)	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 (<i>n=3 plots, 1 burn unit</i>)	No	2008
	>70% Reduction in pole-sized tree density	Pole reduction: After 1 burn: 38% After 2 burns: 46% After 3 burns: 65% (<i>n=3 plots, 1 burn unit</i>)	No	2008
	25-50% Reduction in overstory tree density	Overstory reduction: After 1 burn: 3% After 2 burns: 3% After 3 burns: 8% (<i>n=3 plots, 1 burn unit</i>)	No	2008

* There are numerous longleaf seedlings within the core longleaf area and some additional seedlings near the Bluff Campground.

Monitoring efforts were also very successful, as detailed in the Review of 2014 Projects section of this report. A combination of long-term plot-based monitoring, remote sensing, perimeter mapping, and basic landscape surveys provide a very comprehensive look at both the effects of the most recent burn and current condition of these burned areas 30 years after the first controlled burn was done in the core RCW area. Monitoring efforts in the coming year will focus on continuing to collect long-term monitoring data and establishment of plots to monitor the planned mechanical tree reduction project.

Table 2. Prescribed burning of the RCW site. Provided for reference.

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
March 14, 2012	575 (units 1-4)	Very complete burn, low-moderate intensity and severity – burned into edge of floodplain
May 6, 2014	575 (units 1-4)	Very complete growing-season burn, low to moderate-high severity with notable canopy scorch

Cumberland Gap National Historic Park (CUGA): 2014 Fire Effects Monitoring Annual Report

Activity Summary

The fire effects monitoring crew made two visits to Cumberland Gap during 2014, and an additional visit during January of 2015. The first visit occurred in April, to collect immediate postburn data following the Dark Ridge A/B prescribed burn. An additional trip was made in September to collect additional year-1 postburn data from those same plots. Data and findings from monitoring of this third burn at Dark Ridge A/B are quite exciting and are included in the “Review of 2014 Projects” section of this report. Additional work that was done during the September trip included surveys and spot-spraying of invasive *Miscanthus sinensis* at Dark Ridge, along with long-term monitoring at Tiprell A/B. Finally, during the January 2015 visit, the crew completed year-5 postburn monitoring at Hoot Owl Hollow, and also conducted a pre-burn survey of that unit in advance of the prescribed burn scheduled there for spring 2015.

Program Goals and Objectives

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

In past years’ reports, we’ve used this space to communicate existing goals and objectives and to improve the objectives as new data have become available. There are no significant changes in goals and objectives for CUGA, so in the interest of reducing the length of this report, the reader is referred to the 2011 Annual Report.

Review of 2014 Projects

Dark Ridge A/B Prescribed Burn:

The third entry of fire in the 165-acre Dark Ridge A/B unit occurred on April 1, 2014. This unit lies on the western park boundary, adjacent to private land and at least one permanent residence home. This unit was previously treated with extensive manual thinning along the boundary and was broadcast-burned in 2005 and 2009. The forest type is predominantly mixed oak; several small stands of pine all experienced significant mortality during the 2000-2001 southern-pine beetle attack. The previous burns utilized some significant strip-headfires, which combined with the southern-pine beetle damage to result in patches of overstory mortality and canopy opening.

Several invasive exotic species have been detected in these canopy openings, though the most significant remaining threat is Chinese silvergrass (*Miscanthus sinensis*).

The FEMO report from this year's burn indicates that the fire was primarily a low-intensity backing fire (6-10" flame lengths) with isolated occurrences of higher intensity (15-20' flame lengths) when wind gusts and fuels jackpots aligned. This was the desired fire behavior for this burn, and the FEMO report suggests that all burn-day objectives were likely met, though such a conclusion is greatly complicated by the effects of the first two burns (see **Table 1**), which exceeded the long-term objectives for overstory reduction in this site. Immediate postburn monitoring was done in two long-term plots within a month of the burn, and results from that monitoring confirm that this third entry was relatively low in severity.

Table 1. Fire effects at Dark Ridge A & B (n=2).

Burn Status	% Overstory tree mortality	% Pole tree mortality	Woody fuel load change	Duff fuel load change	Litter fuel load change	Total fuel load change
After 1 burn (2005)	22%	87%	-3%	-38%	-94%	-46%
After 2 burns (2009)	63%	93%	+312%	-48%	-96%	+124%
After 3 burns (2014)	73%	95%	+643%	-67%	-94%	+169%

Note: All percentages are compared to preburn values.

General conditions within the two Dark Ridge A plots is pretty similar, and when data from these plots is averaged, it represents conditions in the mid- to upper slope position of Dark Ridge that lies just below the section that was treated with tree thinning prior to 2005. This is an environment that has experienced dramatic reductions in overstory and pole tree cover (now averaging 28 overstory trees/acre) and similarly dramatic increases in herbaceous and shrub cover. While herb layer data have not been processed in time for this report, the photo of plot

Figure 1. Herb layer in plot QUCO2. This plot had 51 species of herbaceous plants in 2014, nearly doubling the number of herbaceous species recorded during pre-burn monitoring in 2004.



QUCO2 in **Figure 1** is indicative of the high cover and moderate diversity in this part of the unit.

The change in fuel loading is a more complicated story (**Table 1**). As is typical for burns in oak forest, we have seen consistently high reductions in the primary carrier of fire – the oak litter. Also a steady decrease in the duff layer, which is indicative of the increased surface drying associated with the loss of canopy cover. The loss of canopy cover also explains the substantial

increase in woody fuels, as limbs and trees killed by the first two fires fall to the ground and become part of the surface fuels. The increase in woody fuel loading is troubling; however, these changes need to be put into perspective. Under our normal regional climatic conditions, these woody fuels (predominantly composed of 1000 and 10,000 hour fuels) are not consumed at a high rate. In addition, the nature of the surface carrier fuels (hardwood litter) has also changed with the loss of over 70% of litter-producing trees. Reductions in long-term loading of these light fuels should further reduce the likelihood of consumption of the heavier woody fuels. Future fire management planning needs to consider the characteristics of this evolving fuel type.



Figure 2. Seven-foot tall White oak sapling in QUCO1, Dark Ridge A.

This summer's monitoring of Dark Ridge also uncovered one of the most promising finds of the year. Though much of the woody regeneration in Dark Ridge is still dominated by species other than oaks and pines, plot QUCO1 contains many of the finest oak saplings that we have ever seen in the middle of an oak forest (**Figure 2**). In all, we tallied 37 oak saplings (**Table 2**) of four species, with 11 of those taller than 1m. When scaled up from our 5 x 10 meter subplot, this density of oak saplings translates to nearly 900 oak saplings per acre – which is well above the density identified in our long-term management objectives (see **Table 3** later in this report). At the risk of overstating our success with results from a single plot, these numbers and size of oak

saplings represent the restoration of a process (oak regeneration) that is one of the chief goals of prescribed burning throughout the eastern and central United States. In addition, previous year's reports have documented similarly-sized saplings of shortleaf pine at Dark Ridge, which is also a species of great interest from a restoration standpoint. Finally, these plot-sampling results support the more qualitative findings of strong oak regeneration at Lewis Hollow that were discussed in last year's report.

Table 2. Oak saplings at Dark Ridge A and Tiprell A/B (# seedlings > 0.6m tall), after three burns.

Plot ID	Burn Unit	Preburn	After 1 burn	After 2 burns	After 3 burns
QUCO1	Dark Ridge A	2	1	11	37
QUCO2	Dark Ridge A	0	0	0	0
QUCO6	Tiprell A/B	0	0	0	0
QUCO7	Tiprell A/B	0	0	0	0

Other monitoring that was done during summer 2014 in Tiprell (which has also been burned three times) offers some interesting contrasts with the findings at Dark Ridge. **Table 1** shows the oak sapling data from four plots that were monitored during 2014. While only QUCO1 sampling recorded the presence of oak saplings, both of the Dark Ridge plots were observed to contain large oak saplings. QUCO1 contained a far greater number, and the saplings in QUCO2 simply did not fall inside our sampling area.

In stark contrast, neither of the plots in Tiprell contained any oak saplings, despite having also been burned three times. All four plots contained small oak seedlings prior to the first burn, and all contain small oak seedlings today. The difference appears to be the light provided by the canopy openings at Dark Ridge, which is in keeping with well-known oak regeneration dynamics. That said, the rapid opening of the canopy at Dark Ridge has also resulted in negative consequences such as exotic plant invasions, excessive loss of large oak trees, and excessive buildup of heavy fuels. Caution and balance need to be used in applying this knowledge.

One possible conclusion from the monitoring data is that the ideal series of burns for regenerating oak may incorporate a carefully scaled mix of the severities seen at both Tiprell and Dark Ridge. I outlined such an approach in a 2014 USFS Technical Report (GTR-SRS-189), based on fire effects monitoring at CUGA, BISO, GRSM, and KIMO. That section of the GTR is included in **Supplemental Literature** section of this Annual Report. Careful burn planning will likely be required to achieve the correct balance.

Long Term Monitoring Results

There has been no update to the standard analysis of long-term monitoring results. Consequently, **Table 3** has not been updated for this report, though we include it below as a reference point for reviewing the progress toward achieving program objectives.

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

Vegetation 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% (± 3) (n = <u>16</u> plots) After 2 burns = 26% (± 2) (n = <u>11</u> plots)	Not yet, but on course	2013
	>70% Reduction in pole-sized tree density (≤ 15 cm dbh)	Pole Reduction: After 1 burn = 39% (± 5) (n = <u>16</u> plots) After 2 Burns = 67% (± 3) (n = <u>11</u> plots)	Not yet, but close	2013
	15-30% Reduction in overstory tree density (>15cm dbh)	Overstory Tree Reduction: After 1 burn = 5% (± 5) (n = <u>16</u> plots) After 2 Burns = 8% (± 1) (n = <u>11</u> plots)	Not yet, but on course	2013
	>200 tall (>1m) Oak seedlings /acre	Preburn mean: 101/acre (± 12) After 1 burn: 91/acre (± 6) (n=16 plots)	Not yet.	2011
	>30% Cover by native herbs	Mean preburn cover = 2% ($\pm 1\%$) Mean after 1 burn = 4% ($\pm 2\%$) (n=14 plots)	No, but more burns are needed.	2011
	< 20 Invasive exotic plants/acre	Preburn avg: 0/acre Post burn mean: 20/acre (± 14) (n=16 plots)	Unclear due to high variability.	2011

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

Conclusion

Long-term fire effects monitoring continues to reveal exciting changes in vegetation dynamics at Cumberland Gap NHP. Increases in oak and shortleaf pine regeneration along with enormous increases in herbaceous diversity at CUGA represent great progress toward the achievement of important management goals that will help to maintain resilient natural communities. Research at other parks with similar forest types and fire ecology is showing us that structural and compositional variability across the Appalachian landscape are vital for maintaining the diversity of many forms of life, including birds, reptiles, pollinating insects, and rare plant species. New research is also teaching us that fire has played a key role in maintaining this structural and compositional variability for thousands of years. Returning fire to the Cumberland Mountain landscape is an important long-term project, and the CUGA prescribed fire program helps to lead the way with its use of monitoring and adaptive management to make continual improvements to the restoration process.

Great Smoky Mountains National Park (GRSM): 2014 Fire Effects Monitoring Annual Report

Activity Summary

The monitoring crew continued work on a large number of monitoring efforts, prescribed burns, and related projects in Great Smoky Mts. N.P. during 2014. The largest amount of time was spent in pre-burn monitoring, ignition planning, and post-burn monitoring of the burns at Lynn Hollow, which occurred on March 21st and April 1st, 2014. Pre-burn monitoring efforts included resampling a network of plots within the burn site that were established over 15 years ago and had last been burned in 1999. The fire-effects/fire ecology staff was also instrumental in the completion of these prescribed burns, helping to develop ignition plans specifically designed to produce the desired effects, and serving on the ignition crew during both burns. Finally, numerous monitoring trips, long-term sampling efforts, and burn severity mapping were all used during 2014 to evaluate the burns and document the effects on vegetation and fuels within that landscape. A further discussion of this important project and the monitoring efforts there are included in the “Review of 2014 Projects” section of this report.

Exciting new work was also done in support of the planned burn of Arbutus Ridge in 2015. Two new long-term monitoring plots were established in the North Arbutus area and significant work was completed towards building containment lines and planning the ignition of these interesting burns. Finally, the crew completed 10-year post-burn sampling of our long-term plots in the Hatcher Mountain burn unit. This area was prescribed-burned in 2005, and since then has experienced a 1000-acre wildfire and impacts from the tornado of 2011. Aside from collecting long-term monitoring data, our fieldwork there also included scouting an outstanding (and possibly quite old) mixed pine stand near the Little Bottoms Trail, and observing outstanding oak and yellow pine regeneration near the Hatcher Mt. Trail. These findings warrant additional study in the coming year, and can further enhance our understanding of disturbance and vegetation dynamics in the western end of GRSM.

Other important projects included planning, implementation, and monitoring of prescribed burns in Cataloochee and Cades Cove. The Mathews Branch burn in the Cataloochee area and the fall 2014 burns within Cades Cove are also discussed in the “Review of 2014 Projects” section. Finally, significant work continued in our efforts to improve the use of remote-sensing to map the burn severity of fires in GRSM and elsewhere. Aside from contributing to Scott Abl’s M.S. work on burn-severity mapping (see the Research Update section of this Annual Report), our staff is collaborating with the fire-effects team at Shenandoah N.P. to combine nearly 15-years worth of field data to validate and improve the utility of remote-sensing products. This project should result in important products that can be shared in next year’s annual report.

Program Goals and Objectives

One of the successes of our fire-effects monitoring program has been its contribution to the development of short and long-term objectives for the prescribed fire program. Monitoring data

have been continually used to evaluate and improve objectives, and this is indicative of major advances in understanding Appalachian fire ecology over the past 15 years.

In past years' reports, we've used this space to communicate evolving goals and objectives as new data and knowledge have become available. This year there are no significant changes in goals and objectives for GRSM, so in the interest of reducing the length of this report, the reader is referred to the 2011 Annual Report. The long term objectives are summarized in **Table 3**.

One notable thing to add here is that as landscape-level Burn Plans for the North-of-Abrams Landscape and the Cataloochee Landscape were revised during 2014, we were able to update the "Resource Objectives" section to capture state-of-the-knowledge ideas on both short and long-term objectives for achieving the Park's restoration goals. Having these objectives listed in these plans is a vital link in using monitoring data to improve burn practices and outcomes.

Review of 2014 Projects

Lynn Hollow Prescribed Burn:

(The following is adapted from the "Success Story" that was submitted to the National Cohesive Wildland Fire Management Strategy Program following the burn in 2014)

The Lynn Hollow prescribed burn of 2014 represents a watershed event in an ongoing effort to achieve simultaneous goals for Community Wildfire Protection and Ecological Restoration in the mountains of East Tennessee. Lynn Hollow, a 300-acre site just inside the boundary of Great Smoky Mountains National Park in Blount County, Tennessee (**Figures 1 and 2**), is home to old-growth shortleaf pine and oak woodlands, which need periodic fire in order to be sustained. Sharing that same Park boundary, the Top of the World Community (TOWC) lies in an area where frequent wildfires threaten human safety and homes. The many partners in this project, which include the National Park Service (NPS), TOWC Land Owners Association, Tennessee Department of Forestry (TDF), and the Blount County Fire Protection District (BCFPD) have been working for over 15 years to overcome challenges in order to achieve the dual missions of protecting human life and property and preserving this rare example of an ancient forest.

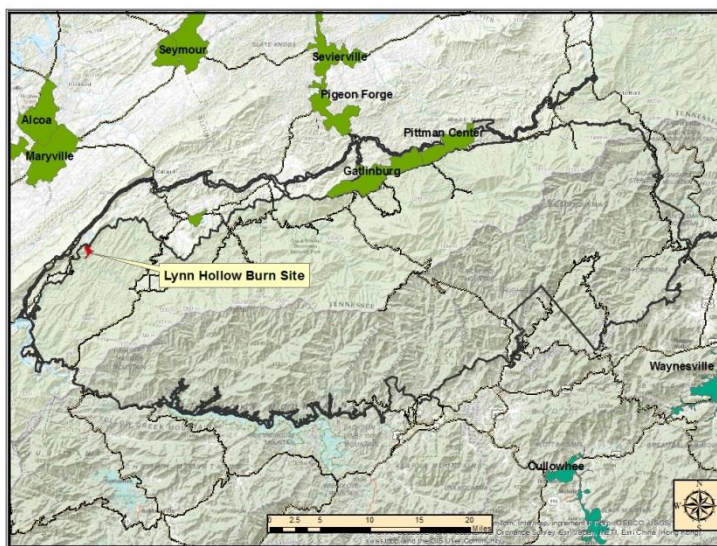


Figure 1. General location of Lynn Hollow

Lynn Hollow 2014 Rx Burn

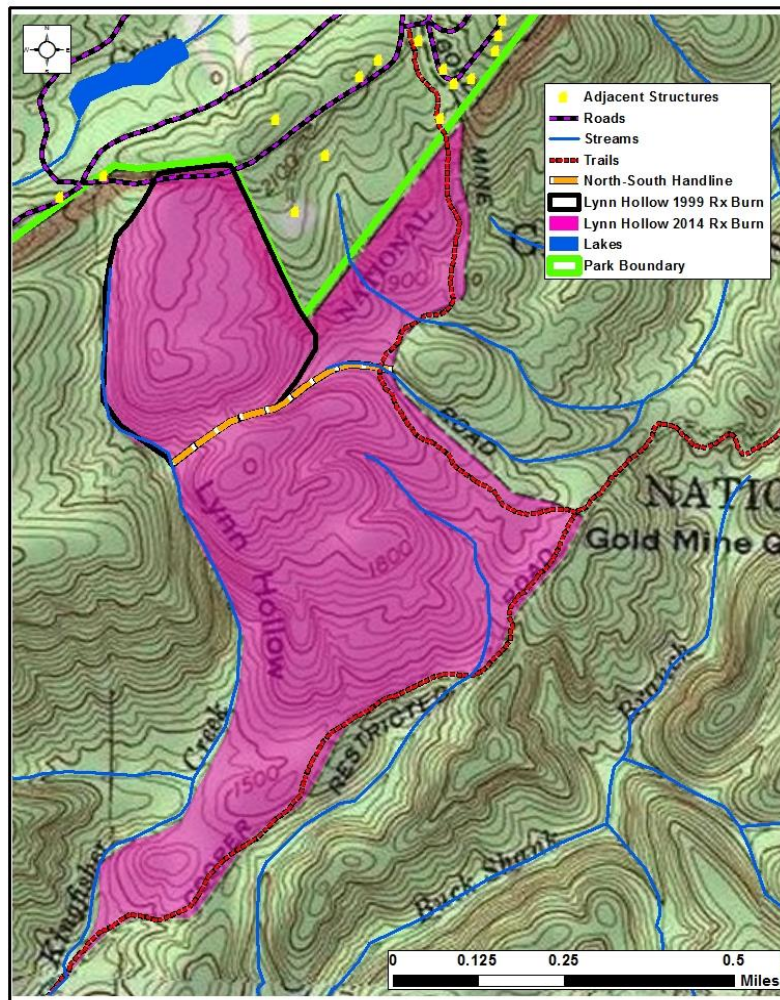


Figure 2. Lynn Hollow Burn Site. The portion north of the North-South Handline burned March 21, 2014, and the southern portion burned on April 1, 2014. The smaller area to the north (black outline) also burned in 1999.

The big trees of Lynn Hollow have long been known as a special resource. Studies have shown these shortleaf pines and associated white, black, and chestnut oaks to be 200-400 years old, making them among the oldest trees of their kind in the world. Just as important, these exceptional trees exist within a large protected landscape of Pine-Oak forest that has provided a stable ecosystem through countless fires, storms, and droughts across the centuries.

The unique natural heritage and ecological resilience of this landscape are now threatened by changes that stem from the 80-year lack of fire within the park. Recent work by researchers from the University of Tennessee and Texas A & M University tells the story of how frequent fires once maintained open pine-oak woodlands at Lynn Hollow. The research also tells how



these woodlands have been disappearing since the advent of fire exclusion, with pines and oaks replaced by species that are less tolerant of the fires and droughts that will eventually occur.

Great Smoky Mountains National Park first treated 60 acres of this area during one of the earliest prescribed burns completed in Park history in June of 1999 (**Figure 2**). Aside from the ecological imperative to restore this once magnificent forest, Park managers also recognized the risk posed to the surrounding community by the wildland fuels that had accumulated over decades of fire exclusion. This small burn was deemed a successful first-entry, and the knowledge gained from it was applied to numerous larger burns of the surrounding landscape in the years that followed.

In 2008, Park managers began making plans for the next Lynn Hollow burn, plans that included significant additions of critical Wildland-Urban-Interface and old-growth shortleaf pine. In 2010-2011, NPS fire crews completed a substantial fuels-thinning and piling project along the Park boundary, and the piles were burned during the spring of 2012. Meanwhile, the homeowners of the TOWC were furthering their Fire Adapted Communities strategy by working with BCFPD and TDF. In addition, their initiative to take independent action and submit a grant request resulted in the National Fire Protection Association selecting them for a \$500 Wildfire Community Preparedness Day award that was used to reduce woody debris and hazardous fuels around community homes.

Despite these successes, numerous obstacles were encountered during the effort to return prescribed fire to this site. Challenges included balancing opportunities to burn with concerns for Indiana bats, a highly endangered species that uses pine snags in and around Lynn Hollow for roosting habitat. These concerns were ultimately addressed successfully through communication and partnership with the Cookeville Field Office of the U.S. Fish and Wildlife Service. Other major obstacles included concerns with managing smoke impacts to the surrounding communities, waiting for burning conditions appropriate for the preservation of the old trees, and maintaining project support through several false starts. Again, partnerships proved to be crucial for successfully overcoming the obstacles: The Nature Conservancy and National Parks Conservation Association were particularly important for helping to maintain the focus and increase public awareness of this important project, and their efforts led directly to outstanding pre-burn press coverage in the Knoxville News Sentinel newspaper.

After all the hard work, Lynn Hollow was finally burned over several days in late March and early April of 2014, and the results have been phenomenal. The ecological objectives of the burn included:

- Significant reductions in both fine fuels (litter) and total fuel loading
- Heavy reductions of fire-intolerant saplings and small trees
- Protection of old-growth shortleaf pine and oak trees
- Improved habitat for pine and oak seedlings as well as grasses and wildflowers.



Monitoring of the site in the following weeks and months revealed an excellent burn that achieved many of these objectives (**Table 1**). Though only a very small sample, these data provide an example of the kind of effects observed at Lynn Hollow. For fuel loading data, these percentages can be considered a good representation of fuel loading changes throughout the pine and oak habitat; overstory, pole, and sapling mortality figures tend to have greater variability within a site following a burn, though extensive qualitative surveys throughout the unit suggest that these values are good representations of effects across the unit. In general, these burns resulted in large reductions in litter, good reductions in total fuels, good top-kill of shade-intolerant saplings, and few impacts to larger trees. The fire was quite intense in places, and higher levels of tree mortality (esp. poles and saplings) were observed in several places, though, again, overstory mortality appears to be very limited.

Table 1. Fire effects at Lynn Hollow. (n=3)

Burn Status	% Overstory tree mortality	% Pole tree mortality	% Sapling mortality	Woody fuel load change	Duff fuel load change	Litter fuel load change	Total fuel load change
After 1 burn	No Change	No Change	31%	No Change	-16%	-99%	-25%

Notes: All percentages are compared to preburn values.

Saplings are trees greater than 1m tall but less than 2.5 cm dbh.

Careful planning and implementation guidelines based on years of knowledge gained from monitoring allowed the Park to burn for maximum effect while protecting the remnant big trees. Symbolic of these positive effects was the post-fire appearance of a profusion of flowering pink-lady-slipper orchids basking in the sunny, open conditions created by the burn (*see the cover of this Annual Report*). Such was the display that the flowers and the burn were again featured in a full-color newspaper article by The Daily Times of Maryville (TN), and the story was also picked up by other large regional newspapers.

Mathews Branch Prescribed Burn:

Mathews Branch is a 275-acre burn unit in our Cataloochee Landscape that was burned on November 5, 2014. This was a first-entry burn into a unit of primarily dry and dry-mesic oak forest with significant amounts of white pine. The objectives called for a light burn as the first entry in a long-term project to restore the structure and composition of oak woodlands with the goal of benefitting elk and other wildlife species.

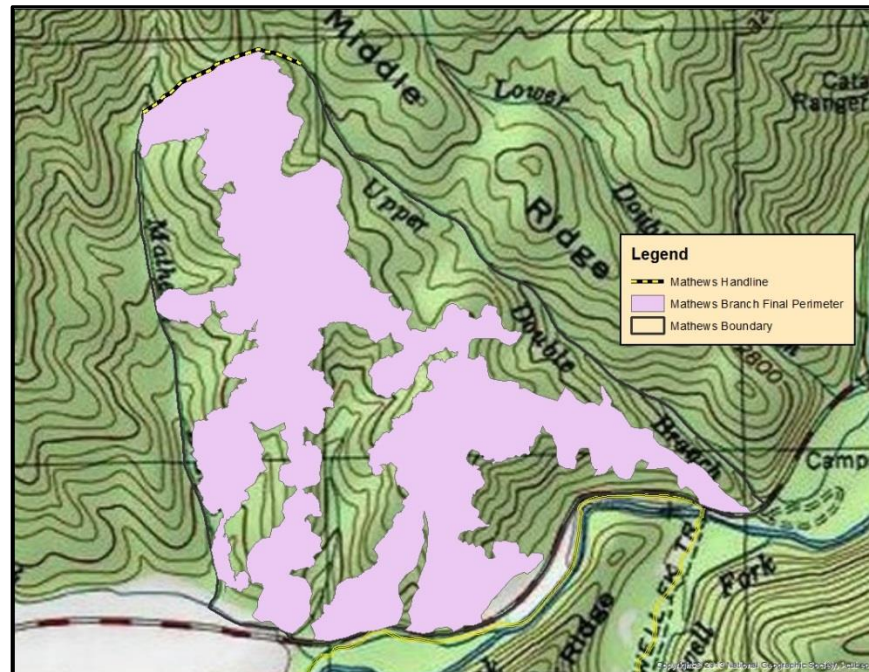


Figure 3. Planned and actual perimeters for the Mathews Branch Prescribed Burn

Additional objectives were to contain the burn using primarily natural boundaries, thus helping to reduce both the amount of fireline construction and total cost. The burn was conducted under relatively cool and moist conditions, which contributed directly to the achievement of most of the stated objectives. Post-burn mapping of the actual burned area (**Figure 3**) revealed a ragged perimeter with large pockets of unburned area. While this is well within the desired results, these findings point to possible improvements for future burn operations. Most of the unburned area is occupied by mixed hardwoods, and thus is not included in the targeted acreages for the burn; however other areas, such as the unburned pocket in the northwestern part of the unit, are more oak and pine dominated. As such, we would like to get a little more burn coverage in these areas. One possible solution would be to patrol for unburned areas as time permits and help to augment fire spread into these areas. In total, this was still an outstanding burn and it appears to have achieved the stated objectives for fuel reduction and top-kill of small trees.

Cades Cove Prescribed Burns:

The GRSM fire program burned 6 separate field units in Cades Cove during 2014, for a total of approximately 300 acres (**Table 2**). As has been the case for the past 5 years, most of the Cades

Cove burns were completed during the month of November. A single unit, Upper Tater, was burned in late February.

Table 2. 2014 Cades Cove prescribed burns.

<i>Field Name</i>	<i>Date Burned</i>	<i>Final Acreage</i>
Upper Tater	02/24/14	40
Methodist Church	11/10/14	38
Cemetery Marsh	11/10/14	75
Upper Old Field	11/11/14	25
Lower Old Field	11/11/14	65
Rowans Creek	11/20/14	54

Though each of the fields in Cades Cove is unique, a common theme emerged from this year's fire effects monitoring. Several of the fields that were burned have significant woody encroachment that has gotten progressively worse due to not burning or cutting frequently enough, or not burning with the optimal seasonality. It is not clear that the fire program alone has the resources to remedy these issues, but what is clear is that more comprehensive interdisciplinary planning will be required to meet GRSM goals for maintaining the cultural and natural landscape of the Cades Cove fields.

Good accounts of each of these burns can be found in the Fire Effects Monitoring Reports (FEMO Report) that were prepared individually for each burn. These reports contain notes on fire behavior, fire effects, and recommendations for future burns. For the GRSM audience, these reports can be found locally on the GRSM server at the following address:

V:\Fire_Mngt\Fire_Records\Prior Years\CY2014.

Long Term Monitoring Results

No new analysis of long-term monitoring results is available for this report. If the prescribed burns of Arbutus and Stony Ridges are completed in 2015, the combination of those results plus the data from the Lynn Hollow burn will warrant an update of the long-term results. **Table 3** contains the most up-to-date analysis of long-term monitoring objectives that is available for GRSM.

Conclusion

2014 was another successful building year for the fire-restoration program at GRSM. Prescribed burns at Lynn Hollow, Mathews Branch, and Cades Cove all represent major successes in effective management of forests and fields at the nation's most visited National Park. The Lynn Hollow prescribed burns provide a particularly strong example of how research and monitoring

contribute directly to identification of high-priority restoration sites, and to successful project planning and implementation. Monitoring was also crucial for the validation of this success and development of recommendations for future program improvements.

Table 3. Objectives and long-term monitoring results for GRSM

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

Kings Mountain National Military Park (KIMO): 2014 Fire Effects Monitoring Annual Report

Activity Summary

The monitoring crew made one trip to KIMO during 2014. There were no prescribed burns completed in 2014, so field work focused on long-term monitoring, burn severity mapping, and planning for 2015 burns. Monitoring was completed in the Turkeybeard, West Garner, and Piedmont burn units. Burn severity mapping in the Piedmont unit resulted in the discovery and sampling of a unique Post oak woodland that may represent a much more common vegetation type in the Park during historical times. This area is more fully described in the “Review of 2014 Projects” section of this report. Finally, the crew also met with Dr. Cecil Frost, who is conducting research on the Presettlement Vegetation and Fire Regimes at KIMO. The crew was joined by Dr. Frost for a field trip along the Brown’s Mountain Trail to view the effects of several burns on the Park’s vegetation, and also for some long-term monitoring plot work at Turkeybeard.

Program Goals and Objectives

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

In past years’ reports, we’ve used this space to communicate existing goals and objectives and to improve the objectives as new data have become available. There are no significant changes in goals and objectives for KIMO, so in the interest of reducing the length of this report, the reader is referred to the 2011 Annual Report.

Review of 2014 Projects

Monitoring Uncovers Interesting Vegetation Type at KIMO:

While conducting Landscape Fire Effects Mapping within the **Piedmont** prescribed burn unit during our summer visit, one of our vegetation sampling sites fell in a grassy Post-oak woodland (**Figure 1**). While not a particularly rare plant community overall, this vegetation type is somewhat uncommon at Kings Mountain. The park’s Community Classification (Natureserve 2005) lists this as *Appalachian Shortleaf Pine –Post Oak Woodland (CEGL003765)*, and says that it is uncommon and scattered throughout the park. Natureserve also notes that this community type is probably in decline due to fire exclusion.

Past fire-effects monitoring has documented examples of this forest type, though they are typically very small and have a poorly developed herbaceous layer. Though this is also a pretty small occurrence, this stand has the best combination of post oak basal area, woodland structure, herb cover, and plant diversity (45 species in a 20m x 20m plot is quite high for Kings Mt.) that we have seen the in the Park (**Figure 2**). Our sampling included observations of an eastern hognose snake and scarlet tanager within this area.

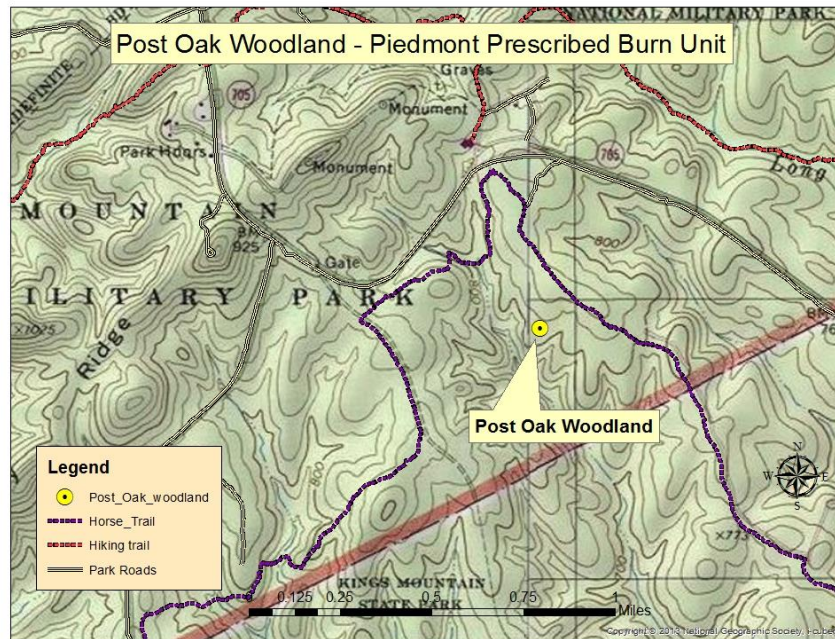


Figure 1. Location of Grassy Post Oak Woodland in Piedmont Burn Unit



Figure2. Post Oak Woodland with high cover of native grass.

Long Term Monitoring Results

2009 was the last time that long-term monitoring results for KIMO were updated (**Table 1**), but there was not enough data collected during 2014 to improve the current analysis. As noted before, the results indicate that KIMO is on track toward achievement of its management objectives. Despite the large number of plots at KIMO, however, there are significant trends in fire effects that are not being captured in the plot data. These trends are still being explored, and have been discussed in previous reports and presentations.

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

Monitoring Type	Management Objective Restoration Phase- (After 4 burns)	Monitoring Results (80% confidence intervals)	Objective Achieved?	Year Last Analysis Completed
Chestnut Oak-Blackjack Oak Woodland (FQUMA1) <i>8 plots</i>	>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 (FQUM01) <i>21 plots</i>	>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

Conclusion

Despite the lack of prescribed burning at KIMO during 2014, the fire-effects monitoring crew continued monitoring efforts and also supported planning for prescribed burns that are planned in FY15. Aside from the collection of valuable long-term monitoring and burn severity data, this year's field-work also resulted in the "discovery" and sampling of an uncommon grassy woodland that may have once been more abundant in the KIMO landscape. This vegetation type has a relatively diverse flora and is dependent on fire for maintenance. This and other occurrences of this vegetation type are an important part of the Park's natural history, and should be considered high priorities for fire-restoration.

The crew also worked with Dr. Cecil Frost to support his ongoing research on modelling the Presettlement Vegetation and Fire Regimes of Kings Mountain and Cowpens NB. Examples of how Dr. Frost's products have been developed and ideas for how they can be used are provided in BISO section of this Annual Report.

Moore's Creek National Battlefield (MOCR): 2014 Fire Effects Monitoring Annual Report

Activity Summary

The fire effects monitoring crew was represented by the Lead Monitor during this year's prescribed burns at MOCR. Activities included acting as FEMO during the burn, conducting post burn assessments of the burns, documenting mechanical mastication work, and creating treatment polygons for all treated areas.

Program Goals and Objectives

Based upon the goals and objectives in the Incident Action Plan (IAP) for the 2014 prescribed burns, it appears that the ecological goals for these burns are to reduce hazardous fuels, promote regeneration of fire-adapted species, and minimize the spread of exotic plants. The objectives to achieve these goals include:

- Reduce 1 hr, 10-hr, and 100-hr fuels
- Top-kill understory trees
- Minimize mortality of overstory trees
- Minimize exotic plant densities

Review of 2014 Projects

Savanna, West, and South Prescribed Burns and Mechanical Fuel Reduction:

Moore's Creek National Battlefield is located 20 miles northwest of Wilmington, N.C. in Pender County, NC. It is a Revolutionary Battlefield that dates back to 1776 and was a significant location due to the Patriot Victory along the said Moore's Creek. The park is approximately 88 acres in size surrounded in the uplands by Loblolly pine plantation.

Pender County is a notable county in North Carolina because of its size and also the site of the lost "Big Savannah" as discovered by B.W. Wells in 1920. Wells described The Big Savannah as treeless; which was unusual for savannahs in the state. To note, a paragraph taken from North Carolina Coastal Land Trust website describes the area as such; *The Liddell soils are high in silt and very fine sand and drain poorly. They extend some fifty square miles in Pender County and may have once been an ancient lakebed.* When biologists examined aerial photos of the area taken in 1938 and beyond, they determined that the historic openness of the area could have developed in response to frequent fire.

A significant black-water creek flows through the park and is the key feature in the battle for MOCR is named. The creek is a 3rd order stream to the Black River with a significant riparian forested-wetland vegetation component. A planted and restored lowland area known locally as the “Savannah” is located directly southwest of the visitor center, and is currently being managed as a fire-adapted landscape. This site contains several state-listed plant species.



Figure 1. Remnant Atlantic White-cedar forest at MOCR

Past vascular plant surveys discuss the presence of several state rare species associated directly with the Savannah or the Fire Break boundary. The first potentially still viable species is *Solidago verna* (spring flowering goldenrod), which is associated with the open conditions of the meadow or “savannah” burn unit. The second species of concern for managers is *Ilex amelanchier* (sarvis holly) and as stated in the 1984 Floristic Inventory, it may need to be protected while prepping or trimming along the west fire line: It is known to be 6” away from square concrete boundary marker 11 feet from west boundary line of the Park.

One vegetation community stands out for the entire park as a true remnant and is labeled as Atlantic White-cedar/Shining Fetterbush Forest (CEGL007563). It is located south of the Savannah along a seep draining west of the Savannah site as noted by Nature Serve and Resource Manager James Sutton (**Figure 1**). Several Atlantic White-cedars (state “vulnerable” per Nature Serve) occupy this site as shown in the photo above.

The 2014 burns accomplished at MOCR were the result of non-Fuels NPS funding and were the largest area treated in the Park’s history. The units were broken up into three prescribed fire units; Savannah, West, and South, and areas treated with skidsteer masticator (**Figure 2**). The Savannah unit is the only one of these units that has received consistent burning over the years (**Table 1**).

Table 1. Burn History of the Savannah unit.

Unit Name	Dates Burned
Savannah	3/8/1989
	3/19/1990
	4/9/1991
	3/9/1992
	3/1/1993
	2/24/1995
	3/17/2010
	2/10/2012
	4/22/2014

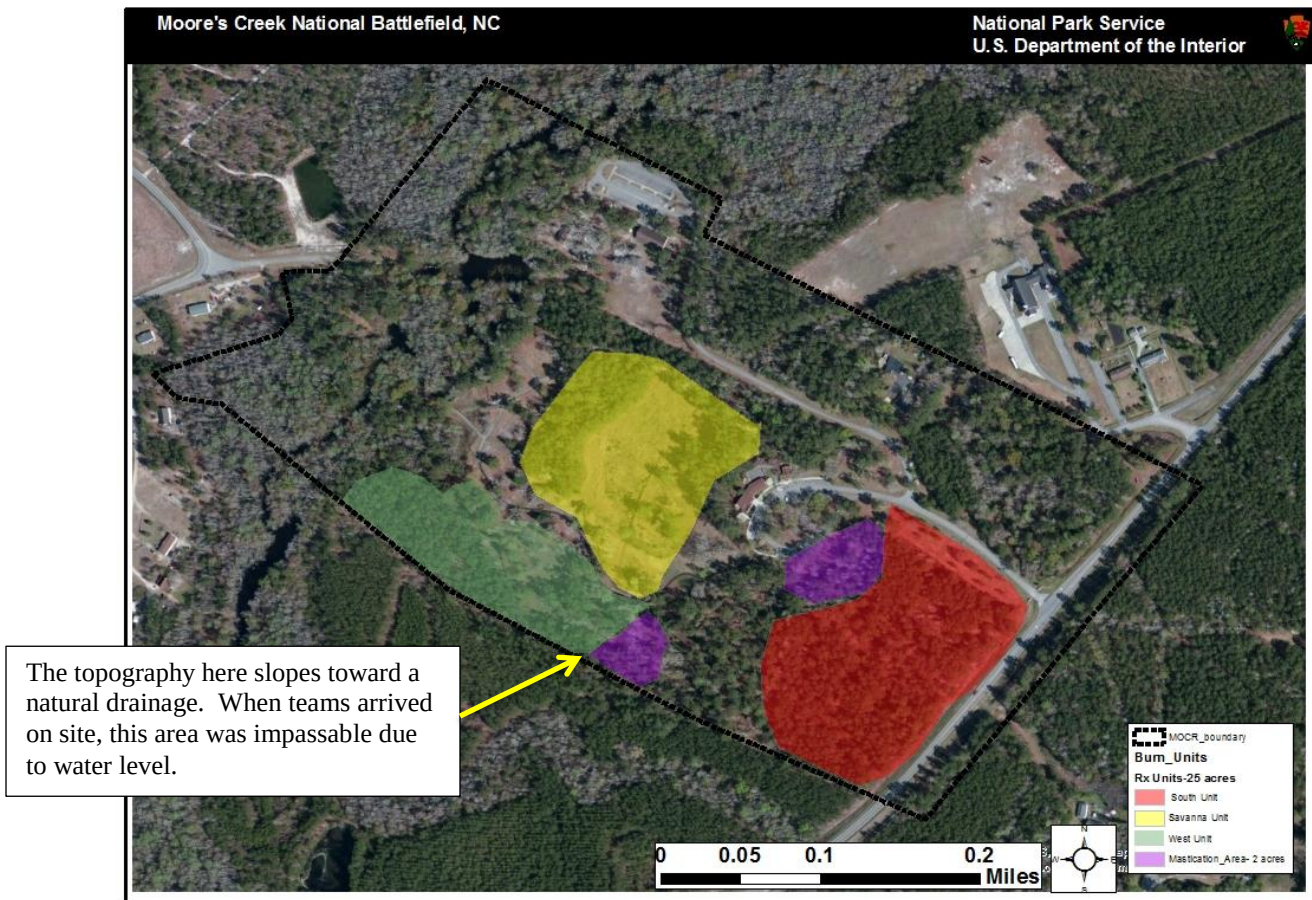


Figure 2. Burn units and Mechanical Treatment areas of MOCR, 2014

Pender County received 3+ inches of rainfall 2 days prior to the burn. Fire breaks were impassable near where local drainages crossed them. Given these conditions, the idea was

approved to test whether the Savannah would burn or not before introducing fire to the wooded areas.

Considerable volunteer work was used in thinning hardwood resprouts in the “Savannah” and eastern edge of the Earthworks woodlot area prior to the burn. This was done to expedite the achievement of the long-term restoration objective for reducing pole-sized tree density by 70%.

The ignition (**Figure 3**) of the Savanna unit was essentially strip-firing starting in the northwest corner and working east to secure the line then south side of the 4 acres. Fire behavior was moderated by wet conditions in this area due to the early start times and saturated soil. In the future it would be more desirable to burn the field portion with greater intensity under slightly drier conditions. With that being said, the burn appeared to achieve the objective of reducing the 1 hour fuels by at least 50% over 75% of the target landscape as measured immediately post-burn.



Figure 3. Savannah ignition and fire behavior

With the Savannah unit deemed a success, the South unit along the Main Park drive and Highway 210 was ignited next. Ignition began later with this unit, and as the day progressed the fuels became noticeably drier. As igniters approached the southwest corner of the unit, fire behavior, fuel consumption, and crown scorch on young loblolly pines all increased. Although the ground fuels were drying out slowly, the low live-fuel moisture and flammability of the shrub layer became an important factor in fireline intensity. This phenomenon of rapid drying of fuels and increased flammability may have surprised igniters. However, with the winds light, very little head fire was seen. The photo below depicts fire behavior associated with the first entry burn and fuel load in the South burn unit (**Figure 4**).

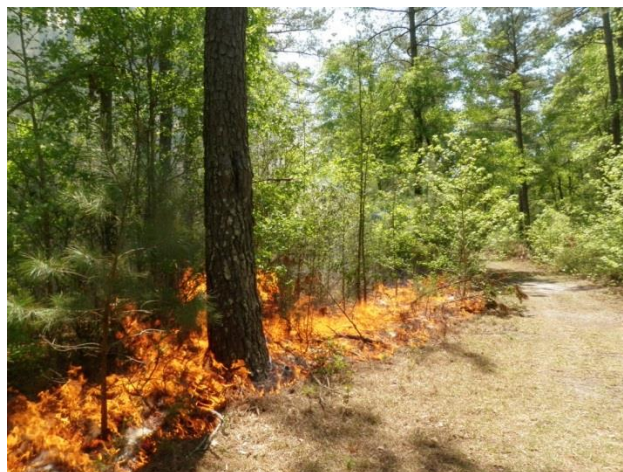


Figure 4. Fire intensity along Tarheel Trail in the South unit

The West unit, which was ignited last in the day, is a complex unit with a mixed land use history. It is bordered to the north by the History Trail and lawn. Several monuments occupy this area and mowing is interspersed with good-quality savannah vegetation. To the west, the unit is bordered by a very wet Moore's Creek with coastal plain riparian vegetation. The south side of the unit is dry; a wide Fire Break Road exists here, separating the park from a very sandy-soil Loblolly pine plantation on private land. The east side of the unit has some natural drainage and a population of Carolina bogmint, *Macbridia caroliniana* (communication with James Sutton) associated with the wet vegetation. One acre of the east side of this drainage was masticated and care was taken to leave existing, planted long-leaf pine seedlings.

The interior unit is made up of several remnant drainage canals and the remnant Atlantic White Cedar/Shinning Fetterbush forest. The site that is occupied by the community is closer to the west side of the unit and is a low seep or depression caused by landform and soils. There are several Atlantic white cedars at the site, interspersed with Loblolly pine, black gum, and occasional bald-cypress. The shrub layer is complex mix of blueberry sp., fetterbush, Ilex sp., and azalea sp. Also associated with this area, mostly on the north side of the seep is a canebrake of *Arundinaria tecta*. The space of this area may be less than 0.5 acre. This area was briefly mentioned but never scouted prior to the burn.

Ignition of the West unit began along the History trail in the NW corner with a variety of fire behavior but mostly backing. Fire backed slowly to the drainage/seep area and extinguished. As the ignition squad turned across the road on the west side and began bringing fire east, wind drove the fire and sent head fire through the shrub layer with the greatest intensity seen all day. It should also be noted, at the time of the 1st burn for the day, water was no longer present in the drain bisecting the Fire Break road (**See Figure 2**). Flame lengths were observed to be 10-20 feet in this area, and fire pushed off the line in a continuous head-fire. Rh had basically hit the lowest for the day (34%) and this coincided with the highest intensity fire behavior seen that day day (**Figure 5**). Total ignition time for all units was approximately 3 hours.



Figure 5. Intense head-fire in the West unit. Photo was taken from the seep area looking towards the Fire Break Road.

Objectives for the South and West units, such as reduction of fuel loading and pole-trees, appear to have been met, though no formal sampling was conducted. In the future, if funding issues are not a constraint, some type of monitoring would be helpful to quantify whether objectives are being met. Additional work could also be done to ensure that the objectives are appropriate for this site. Without appropriate objectives to guide the burn planning and implementation, the

outcomes of burning in these fuel types may be more severe than desired, including unplanned impacts to the very small remnant of Atlantic white cedar (*Figures 6 and 7*).



Figure 6. Immediate post-burn effects included consumption of shrub foliage. Atlantic white-cedar area is in the background.



Figure 7. Looking towards Atlantic white cedar forest. 1st Growing season after the burn.

Strong bracken fern response is indicative of moderate-high fire severity.

Further work was done at Moore's Creek with regards to thinning and mastication. There were two, approximately 1 acre areas that were carefully treated with the skidsteer. Most work involved clearing saplings and understory shrubs and leaving planted long-leaf pine seedlings. Minimal soil disturbance occurred and care was taken to rake over tracks where the top layer of soil was disturbed (**Figure 8**). Lastly, these project polygons were mapped using garmin GPS units and a geodatabase was created with the data. They will be entered into the National Fire Occurrence Geodatabase for MOCR.

Figure 8. Skidsteer mastication project results.



Long Term Monitoring Results

There are no long-term monitoring results available for MOCR at this time.

Conclusion

The ecological/fuels goals and objectives need to be reviewed and possibly revised. Current goals and objectives are the same as those for Appalachian hardwood forest, even though MOCR is located in the Coastal Plain, and differs considerably from the vegetation and ecology of the mountains. Given the small size of the burn units and the high percentage of the park that is being burned, it is also recommended that the objectives should explicitly address desired outcomes and/or protection requirements for rare species that occur in the park, such as Atlantic white cedar, sarvis holly, spring-flowering goldenrod, Carolina bogmint, and Carolina grass-of-Parnassus.

Additional Program Information

Table 1. Planning - 2014

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 2014)	Assisted with how many BAER plans in 2014?
BISO	yes	n/a	0	0
BLRI	yes	n/a	0	0
CAHA	no	n/a	0	0
CONG	yes	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
MOCR	no	n/a	0	0

Table 2. Monitoring - 2014

Park	% 2014 Data Entered	% 2014 Data Quality Checked	# Prescribed Fires Monitored*	# Non-fire Fuels Treatments Monitored*	# Wildfires Monitored*	# BAER Treatments Monitored*
BISO	25%	0%	1	0	0	0
BLRI	None	None	0	0	0	0
CAHA	None	None	2	0	0	0
CONG	25%	0%	4	1	0	0
COWP	None	None	0	0	0	0
CUGA	25%	0%	1	0	0	0
GRSM	25%	0%	7	0	0	0
KIMO	25%	0%	0	0	0	0
MOCR	None	None	3	1	0	0

*Includes units with Pre and Post burn monitoring only

Table 3. Communicating Results - 2014

Park	# of Project Monitoring Reports completed in 2014	# of Annual meeting(s) with Park staff	# of Formal presentations of results	Do you use Minitab?*
BISO	1	1	0	Yes
BLRI	0	0	0	Yes
CAHA	2	1	0	No
CONG	3	1	0	Yes
COWP	0	0	0	No
CUGA	1	1	0	Yes
GRSM	8	1	0	Yes
KIMO	0	1	0	Yes
MOCR	1	1	0	No

Table 4. Research - 2014

Park	Are research needs identified in FMP or Monitoring Plan? (yes or no)	# of Proposals Submitted in 2014	# of Proposals Funded in 2014	# of Research Projects Supported in 2014*	Additional Comments
BISO	yes	1	1	0	
BLRI	yes	0	0	0	
CONG	yes	0	0	0	
COWP	yes	0	0	0	
CUGA	yes	0	0	0	
GRSM	yes	1	1	6	Heavy support
KIMO	yes	0	0	0	
MOCR	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.

Fire Ecologist and Fire Effects Crew Accomplishments and Areas of Focus

Table 1. Fire Ecologist 2014 Accomplishments/Focus Areas

Category	Percent Time	Accomplishments and/or areas of activities
<i>Detail</i>	20%	90-day detail as SERO Fire Ecologist ; FMP/EA scoping and/or reviews for KIMO, CALO, EVER ; Realignment planning ; Fuels Reserve Research Reviews, Multi-region Fire GIS meeting in Raleigh, NC.
<i>Data Collection</i>	15%	Field work at GRSM, CONG, CUGA, KIMO. FMH, CBI, and LFEM Plot work and qualitative surveys. Preburn, Immediate postburn and growing season postburn.
<i>Planning</i>	10%	Fire Realignment planning ; Fire effects monitoring budget and workload planning ; Site-specific prescribed burn planning (esp. firing planning) ; Overlap with FMP scoping and reviews listed above.
<i>Data analysis</i>	10%	Estimated amount of time spent performing analyses, including data summaries and statistical tests. Tabular and spatial data.
<i>Data management</i>	10%	Work with Systems for Environmental Management to convert legacy databases into FFI; Completion of FFI database for Landscape Fire Effects Mapping; extensive work with dNBR thresholding, QA/QC, data development, etc.; FFI uploads to IRMA.
<i>Supervision/Admin</i>	8%	Budget/Realignment issues. Supervision, Performance evaluations, resignation, IDPs, travel, payroll, crew support, purchasing etc. Meetings.
<i>Fire Assignments</i>	8%	Prescribed burns at GRSM, LIRI; 2 week assignment as ICT5/FFT1 in CA.
<i>Writing</i>	5%	Long-term Restoration Plan for GRSM; Success Story for National Cohesive Strategy; Work on monitoring plans; Proposal writing. Annual report. Detailed correspondence.
<i>Partnerships</i>	5%	Build strong partnership with TNC –TN chapter and NPCA to advocate for continued prescribed fire restoration in GRSM; Meetings, Media Coverage, Planning; Met with USFS – Cherokee NF to build burning capacity
<i>Research</i>	5%	Involvement with several research projects at GRSM, BISO, KIMO (see Research Update). Data support, field support, support letters.
<i>Miscellaneous</i>	4%	Mostly communication; E-mails, phone calls, informal planning discussions.
<i>Training</i>	0	Identify training needs

Table 2. Fire Effects Crew 2014 Accomplishments/Focus Areas

Category	Percent Time	Notes
<i>Planning</i>	15%	Primarily related to prescribed fire and includes participating in planning meetings, extensive pre-burn scouting of project units, providing feedback to operations personnel via maps and oral or written communication, and assisting with the development of formal firing plans based on knowledge of on-site conditions and burn objectives. Also, includes scouting and mapping of a future mechanical treatment project at CONG, as well as routine coordination with the Fire Ecologist to plan and schedule general fire effects monitoring field work
<i>FMH plots</i>	15%	Primarily GRSM along with a few plots at CUGA and BISO. Also assisted NATR Fire Effects with plots at LIRI and HOBE
<i>Qualitative Monitoring</i>	7%	Completed for burn units at GRSM, BISO, CUGA, KIMO,
<i>CBI/ Landscape Fire Effects Monitoring (LFEM) Plots</i>	8%	LFEM plots combine species composition data with a streamlined CBI data collection process. Plots were completed at GRSM, BISO, and KIMO
<i>Wildfire assignments</i>	2%	Crew assisted with a few in-park (GRSM) fires and local response on Cherokee BIA land
<i>Prescribed fire projects</i>	20%	Assisted with prep, implementation, and mop-up of burns at BISO, CAHA, CONG, GRSM, LIRI, MOCR
<i>Non-fire fuels projects</i>	1%	Lead assisted with 2 week long thinning project at BLRI
<i>Travel out-of-park for plot or project work</i>	5%	
<i>GIS</i>	10%	Primarily map making for field work and as a communication tool used in reports, meetings, and presentations, but also includes data management such as FMH and CBI plots databases and Fire History/Fire Occurrence database.
<i>Data entry</i>	8%	Approx. 50% entered
<i>Data analysis</i>	1%	Mostly summary tables for various reports but also includes some work with CBI dataset
<i>Supervision/Admin</i>	5%	Supervision of crew in completing field and office work, and time, travel, and purchasing paperwork
<i>Training</i>	2%	Crew had fire refresher training and misc. on the job training
<i>Miscellaneous</i>	1%	

The End.