



Appalachian/Piedmont/Coastal Fire Management Zone: Fire Effects Monitoring Annual Report, 2018





***APC Zone Fire Effects Crew at Cape Hatteras NS, October 2018
(from left: Rob Klein, Allyson Arulanantham, Wylie Paxton, and Matt Wood)***

On the Cover: *Pre- and Post-Treatment photos of the Gatlinburg/Ski Mountain mechanical fuel-reduction project. This project resulted in a 30 foot wide, mile-long buffer of mulched fuel along the Great Smoky Mountains NP boundary. More results from photo monitoring of this project can be found in the GRSM section of this report.*

Appalachian/Piedmont/Coastal Fire Management Zone: Fire Effects Monitoring Annual Report, 2018

Robert N. Klein Jr.
E. Wylie Paxton
J. Matthew Wood
Allyson R. Arulanantham

National Park Service
Southern Appalachian/Piedmont Fire Effects Monitoring Program
Great Smoky Mountains National Park
107 Park Headquarters Road
Gatlinburg, TN 37738

March 2019

Contents	Page
Introduction	5
Research Update.....	8
Big South Fork NRRRA Annual Report	13
Blue Ridge Parkway Annual Report.....	18
Cape Hatteras NS Annual Report	21
Chickamauga and Chattanooga National Military Park.....	26
Congaree NP Annual Report	29
Cowpens NB Annual Report.....	33
Cumberland Gap NHP Annual Report.....	34
Great Smoky Mountains NP Annual Report	35
Kings Mountain NMP Annual Report	42
Moore's Creek National Battlefield.....	47
Additional Program Information	52
Fire Ecologist and Fire Effects Crew Accomplishments and Areas of Focus.....	54

Introduction

2018 was one of the wettest years on record in the Great Smoky Mountains and throughout much of the APC Fire Management Zone, but progress in prescribed burning, fuels management, fire-effects monitoring, and fire science marched on. The past year saw a number of successes, including continued short and long-term monitoring of prescribed burns, wildfires, and mechanical fuel treatments at 6 Parks for a total of 85 individual plots (**Table 1**). As always, the Fire-Effects crew demonstrated great adaptability in employing a variety of monitoring techniques in habitats ranging from montane pine/oak forests to longleaf pine flatwoods to coastal salt marsh. Other highlights for the year included continued engagement in local and national fire operations, coordination of fire records/mapping, facilitation of multiple research projects/proposals, and leadership in fire education and outreach (**Tables 2 & 3**).

Allyson, Wylie, and Rob supported national wildfire management efforts by serving on the Ferguson Fire in/near Yosemite National Park. For Allyson, this was the first western wildfire assignment, and she gained tremendous insight and experience of fire behavior, firefighting tactics, and large-scale fire management. Assistant Lead Monitor Matt Wood distinguished himself by providing major support for the APC Zone Fuels program, during a 120-day detail as the Lead Fuels Technician and through year-long support of that same position. Matt's continued work in that role has been instrumental in maintaining continuity in our RAWs data collection, weather station maintenance, fuel moisture sampling, and developing a better understanding of NFDRS. All crew members provided strong support for multiple prescribed burns across the zone and Southeast Region, burn unit prep, and the Ski Mt. mechanical fuel reduction project at GRSM.



Allyson and Rob on the Ferguson Fire In Yosemite NP.

The focus of the program continues to be short and long-term monitoring of prescribed burns, mechanical fuel reduction, and wildfires at a number of Parks throughout the Southeast Region. During 2018, monitoring work was completed at: Big South Fork NRR, Cape Hatteras NS, Congaree NP, Great Smoky Mountains NP, Kings Mt. NMP, and Moore's Creek NB.

Major projects included continued work on burn severity mapping for the Chimney Tops 2 wildfire (GRSM), photo-monitoring of the Ski Mountain mechanical fuel project (GRSM), monitoring results after 10 burns of longleaf woodlands at Congaree, and five-year post-treatment monitoring in coastal marshes at Cape Hatteras. Project descriptions and monitoring results can be found in each park's respective section of this annual report.

**Table 1. Appalachian/Piedmont/Coastal Fire Effects Monitoring Program:
2018 Plot Workload and Total Plots Installed**

Park	Monitoring Unit	Plot Type	Pre-burn 2018	Immed. Post 2018	Postburn (1-20 yrs) 2018	Annual Total (2018)	Total Plots
Big South Fork (BISO)	Little Bluestem	FMH Forest Plot					4
	Shortleaf Pine	FMH Forest Plot					2
	White Oak	FMH Forest Plot		2	8	10	13
	LFEM	Species Comp/CBI/Fuels			2	2	21
	CBI	CBI				0	9
	Fuels Transect	Fuels Transect				0	4
Blue Ridge Parkway (BLRI)	Chestnut Oak	FMH Forest Plot					2
	LFEM	Species Comp/CBI/Fuels				0	7
	Fuels Transects	Fuel Transect				0	6
	Photo Points	Photo Point				0	6
Cape Hatteras (CAHA)	LFEM	Species Comp/CBI/Fuels			15	15	17
	Photo Points	Photo Point			12	12	43
Congaree (CONG)	Loblolly Pine	FMH Forest Plot		3	3	3	5
	Longleaf Pine	FMH Forest Plot		5	5	5	5
	Harry Hampton Mastication	Species Comp/CBI/Fuels				0	17
Cowpens (COWP)	Southern Red Oak	FMH Forest Plot				0	2
Cumberland Gap (CUGA)	Scarlet Oak	FMH Forest Plot				0	16
	LFEM	Species Comp/CBI/Fuels				0	10
Great Smoky Mountains (GRSM)	Black Oak	FMH Forest Plot			6	6	8
	Scarlet Oak	FMH Forest Plot		1	3	4	15
	Yellow Pine	FMH Forest Plot			2	2	40
	LFEM	Species Comp/Fuels	3		10	13	49
	CBI				10	10	127
	Photo Points				11	11	11
	Fuels Transect	Fuels Transect				0	7
Kings Mountain (KIMO)	Blackjack Oak	FMH Forest Plot	2	2	4	8	8
	Chestnut Oak	FMH Forest Plot	2	3	4	10	21
	LFEM	Species Comp/CBI/Fuels			2	2	20
	Fuels Transect	Fuels Transect				0	3
Moore's Creek (MOCR)	Photo Points	Photo Point		2		2	2
Total			7	18	97	115	500

Table 2. Summary of 2018 Fuels Treatments and Monitoring

Park	Burn Unit	Plots?	Other Monitoring	Acres
Big South Fork (BISO)	Bald Knob	Yes (Full Plots)	Yes (Qualitative, LFEM and FEMO)	499
Congaree National Park (CONG)	RCW/Harry Hampton	Yes (Full Plots)	Yes (LFEM)	450
Great Smoky Mountains (GRSM)	Little Cataloochee	Yes (Full Plots)	Yes (FEMO)	120
	Sparks	No	Yes (FEMO)	87
Kings Mountain (KIMO)	Brushy Mountain North	Yes (Full Plots)	Yes (FEMO, LFEM Qualitative)	305
Moore's Creek (MOCR)	Savannah, South and West	No	Photo points (FEMO)	38
Total	6	16	36	1499

Table 3. Fire Ecology/Fire Effects Staffing 2018

Team Member	Starting Date	Ending Date	# of Pay Periods	READ Qualified (Yes or No)	Training and Development
Rob Klein (Fire Ecologist)	1/1/18	12/31/18	26	Yes	READ Training; 2-week assignment on Ferguson Fire; participation in Rx burns at GRSM, KIMO, and HOBE; presenter at SBR FLN workshop; several field trips, presentations, and interviews.
Wylie Paxton (Lead Monitor)	1/1/18	12/31/18	26	Yes	READ training coordinator; Grass workshop at Highlands Biological Institute; 2-week HECM assignment on Ferguson Fire in CA; attended FLN workshop; Engine Academy with Florida State parks
Matt Wood (Assistant Lead)	1/1/18	12/31/18	26	No	RAWS/Fire Family Plus training; 120-day Fuels Technician detail; WIMS/NFDRS data management; RAWS station maintenance; WFMI weather station reporting; Fuel moisture sampling at GRSM.
Allyson Arulanantham (STF Crewmember)	3/19/18	12/8/18	19	Yes	READ Training; first 2-week western fire assignment to Ferguson Fire in CA; FEMO trainee on 2 Rx burns; FEMO signed off 3/21/19; Attended FLN Workshop.

Research Update

A great deal of research was underway at GRSM during 2018, most having to do with various fire effects from the 2016 Sevier County Wildfires. Several of these projects have already produced some interesting results, and were presented during the 2019 Great Smoky Mountains National Park Science Colloquium. Abstracts for these projects are provided below, followed by a list of active research permits from the Park. Collectively, these projects demonstrate a broad range of fire-related research and build on a growing body of science that can be used to inform Park management and public education.

Abstracts From 2019 GRSM Colloquium

How the 2016 Chimney Tops Fire is affecting plant-soil function in the Smokies.

Kendall Beals (kbeals2@vols.utk.edu, Ecology & Evol Biology, U Tennessee, Knoxville)

As global change accelerates in the coming decades, fire events are predicted to increase rapidly in both rate and intensity. Fire can fundamentally alter abiotic and biotic factors that have profound influences on plant and soil communities and the valuable ecosystem services they provide. The effects of fire on interactions between plants and their root-associated soil microbial communities remains largely unexplored. The 2016 Chimney Tops 2 fire in Great Smokies National Park has created a rare opportunity to examine the effects of fire on plant and soil function. Using soils collected from areas of different burn severity within the Park, we conducted a greenhouse experiment to examine how understory perennial plant species grow across a gradient of soil disturbance. Findings from this research contribute to our understanding of the belowground biotic mechanisms behind ecosystem response to disturbances like fire, which is an essential component to land management and restoration as Earth's natural landscapes become increasingly fragmented.

Overstory mortality and regeneration following wildfire and prescribed fire.

Jennifer Franklin (jafranklin@utk.edu, Forestry, Wildlife & Fisheries, Univ Tennessee, Knoxville); Matthew Aldrovandi (Oak Ridge National Lab, Oak Ridge, TN); Karen Hughes & Jennifer Schweitzer (Ecology & Evolutionary Biology, U Tennessee, Knoxville)

In the Great Smoky Mountains National Park periodic fire is a common natural disturbance that initiates the replacement of overstory trees. Periodic fire is thought have contributed to the prevalence of oaks (*Quercus* spp.) in our forests today, and prescribed fire is used across the eastern US to mimic natural fire regimes with the goal of promoting oak regeneration. However, the effects of fire on forest regeneration are complex, and the specific characteristics needed to promote oak regeneration are unclear. In the fall of 2018, we characterized overstory mortality and regeneration following fire on sites of differing fire intensity, from both prescribed fires and the Chimney Tops 2 fire. To predict delayed mortality, we measured the extent of fire scars. The density and species composition of tree seedlings and of new shoots developing from surviving root systems was measured. Overstory mortality was found to be the best descriptor of fire intensity, and predictor of tree regeneration. The occurrence and size of fire scars was not influenced by tree size or species. Areas of high tree mortality have very few oak seedlings but

surviving roots systems of chestnut oak (*Quercus prinus*), red maple (*Acer rubrum*) and blackgum (*Nyssa sylvatica*) sprouted prolifically. The density of oak seedlings in areas of low intensity burns was similar to that in the unburned plots and did not differ between prescribed fire and wildfire areas.

New evidence of long-term fire and forest history from mesic forests of Great Smoky Mountains National Park, Tennessee, USA.

Sally P Horn (shorn@utk.edu) & Matthew S Boehm (Geography, U Tennessee, Knoxville); Christopher A Underwood (Geography, U Wisconsin, Platteville)

The recent Chimney Tops 2 fire focused new attention on the risks and roles of fire in Appalachian forests. Understanding the long-term interplay of fire and vegetation in the Appalachian region requires us to think about fire over time scales that extend beyond written records and evidence provided by fire-scarred trees. Here we report initial findings from a study of macroscopic soil charcoal as an indicator of long-term fire and forest history in the eastern, Tennessee portion of Great Smoky Mountains National Park. Charcoal fragments from past fires can be preserved for thousands of years in soils and can be taxonomically identified and dated by AMS radiocarbon analysis to provide information on both the timing of past fires and the plants that burned in those fires. From 14 plots across five sites we recovered 54 soil cores. Our sampling plots were located in vegetation presently categorized as cove forest, chestnut oak forest, oak hickory forest, northern hardwood forest, and yellow pine forest. We collected cores in 10-cm increments to the depth of refusal (total ca. 280 core increments) using an Eijkelkamp root auger. Charcoal fragments ≥ 2 mm were isolated from each core increment by wet sieving, and a random subset of fragments was selected for identification and radiocarbon dating. Sixty-two individual charcoal fragments have been identified and submitted for dating. These samples include charcoal from eastern hemlock, white pine, yellow pine, cedar, oak, chestnut, maple, and birch. Charcoal fragment ages mainly fall within the last 4000 years (calibrated age before CE 1950), but several fragments are from 8000 to over 10,000 years in age. Because of the mixing of soil by bioturbation and geomorphic processes, soil charcoal is not stratified by age in park soils. Consequently, reconstructing past fire history from charcoal in soils requires individually dating a large number of charcoal fragments, an expensive undertaking. However, this approach is of great value to understanding the role of fire as a disturbance in Appalachian forests because it allows us to obtain stand-specific information on fire history and forest history over a much longer period of time than is possible using other methods.

Pine and oak mycorrhizal associations in fire zones following the Chimney Tops 2 Fire.

Karen W Hughes (khughes@utk.edu), Alexis Case & P Brandon Matheny (Ecology & Evol Bio, U Tennessee, Knoxville); Andrew N Miller (Illinois Natural History Survey, U Illinois Urbana-Champaign); Ronald H Petersen (Ecology & Evol Bio, U Tennessee, Knoxville); Jennifer Franklin (Forestry Wildlife & Fisheries, U Tennessee, Knoxville); Jennifer Schweitzer (Ecology & Evol Bio, U Tennessee, Knoxville)

Understanding fungal symbionts associated with trees seedling post-fire is important for understanding the legacy effects of fire disturbance on soil biodiversity, as well as forest recovery after fire. *Pinus pungens* seeds germinated in three severe fire zones (Baskins Creek, Two Mile Lead and Cove Mountain) approximately 6 months after the Chimneys 2 fire. Pine seedlings were sacrificed, and roots examined for ectomycorrhizae approximately quarterly for two years. DNA was extracted from individual root tips, PCR-amplified and sequenced to obtain the fungal sequence barcode (nrITS). Mycorrhizae were identified to genus (family or order in a few cases) by a blast search of GenBank. Results show that initial mycorrhizal associations were in the Thelephora/Tomentella group, the Pezizaceae, (especially Sphaerosporella) and Laccaria trichodermomorpha. Both Sphaerosporella and Laccaria trichodermomorpha fruited in severe fire zones. In year two, pine mycorrhizae included the Thelephora/Tomentella, Laccaria, and Suillus, Tylopilus, Xerocomus and Rhizopogon with a reduction in Pezizaceae over time. Oak acorns germinated in moderate fire zones in the spring and summer of 2018 from fall 2017 acorns. Seedlings were collected from a range of burn intensities (medium, low and no burn) and from roots of coppicing oaks in severe burn areas. Overall, the ectomycorrhizal genus *Russula* was most frequently encountered with *Laccaria* and *Thelephora/Tomentella* also significant. More than 20 putative taxa of *Russula* are represented on oak roots, some presently known only from environmental sequences. Overall, both oak and pine share mycorrhizae belonging to *Thelephora/Tomentella* and *Laccaria* but further work is needed to determine if the species within these clades are shared between oaks and pines.

Enhancing the progression chronology of the Chimney Tops 2 Fire with radar & ancillary datasets.

Steve Norman (stevenorman@fs.fed.us, US Forest Service)

The extreme wildfire behavior the Park and surrounding areas experienced in November of 2016 resulted from a peculiar local wind phenomenon called a mountain wave. Compared to other 2016 and historical fires of the Appalachians, the high rate of spread and high severity patches formed during this event stand out, as do the impacts to the foothill communities. Yet our understanding of fire progression has been hampered by limited observational data and the complexity of wind and fire behavior in this mountain environment. NEXRAD II radar provides a continuous "movie" of the clouds and smoke plume during the event, and in this research, that dataset, the Look Mountain webcam and weather station data are used to improve our insights into how this wind-driven fire event unfolded. Further insights arise from comparing high fire severity patches with the behavior of clouds and smoke in the radar time series. Together, this leads us toward a more complete narrative of this important event. As warm fall droughts and wildfire are predicted to increase in the Southern Appalachians with climate change, efforts to learn about the hazards of this phenomenon are warranted.

Mountain wave induced extreme wildfire behavior: the deadly east Tennessee fires of 2016.

Steve Norman (stevenorman@fs.fed.us), William Christie, William Hargrove (US Forest Service)

In many ways, the Sevier County fires of 2016 came as a surprise. Extreme, historically-rare fire behavior is notoriously difficult to predict and quantify in risk assessments. To improve our understanding of hazard and risk in the foothills of and near the Park, we need better knowledge of how mountain winds behave during extreme events. To get at this, we compared the Dec. 28, 2016 wildfire impacts with a meteorologically similar mountain wave event from May 4, 2017 that caused leaf stripping in a way that revealed wind behavior at high resolution. Using 10m Sentinel 2 and 240m MODIS imagery, we map wind impacts across a large part of the eastern Tennessee foothills. As development continues to expand adjacent the park interface, the entire foothills belt of communities may have an underappreciated mountain wave, if not wildfire risk. Aggressive planning and outreach efforts may be needed to limit future losses as the likelihood of extreme weather is expected to increase with climate change. You can download the poster here: <https://forestthreats.org/products/posters/mountain-wave-induced-extreme-wildfire-behavior-the-deadly-eastern-tennessee-fires-of-2016>

Current Research Permits for Fire-Related Research in GRSM

Developing a Fire History for the Mesic, Eastern Portion of Great Smoky Mountains National Park

PI Sally Horn and Mathew S. Boehm
Institution University of Tennessee

Evaluating the effects of 2016 wildfires on soil invertebrates in the southern Appalachians

PI Mac Callahan and Bruce Snyder
Institution US Forest Service and Georgia College

Are there non-additive effects of fire and urbanization on soil properties and plant community assembly and functional traits?

PI Jennifer Schweitzer and John Schwartz, as well as Karen Hughes and Charlie Driscoll
Institution University of Tennessee

Post-fire endophyte/mycorrhizal Study in Table Mountain Pine burn areas

PI Karen Hughes
Institution UT

Fire Effects on Cambial Injury in Shrubs

PI Jennifer Franklin
Institution University of Tennessee

Effects of the 2016 Chimney Tops 2 Wildfire on Salamander Abundance and Diversity

PI Benjamin Fitzpatrick
Institution University of Tennessee

Wildfire Effects on Salamander Populations in Great Smoky Mountains National Park

PI Bill Peterman, Dan Hocking, John Crawford, Joe Milanovich

Institution Lindenwood University, Frostburg State U., Ohio State U., Loyola of Chicago U.

Effects of Fire on Pathogens and Mycorrhizae Associated with Forest Trees and Woody Vegetation in Fire Damages Areas of Great Smoky Mountains Using Illumina Sequencing and Field Plot Collecting of Fleshy Fungi

PI Richard Baird

Institution Mississippi State University

Fire effects on soil and aquatic organic matter in a southern Appalachian hardwood forest: A rapid assessment across the terrestrial-aquatic interface following the Great Smoky National Park Fire of 2016.

PI Mike San Clements and Jeff Hatten

Institution University of Colorado/NEON

Big South Fork National River and Recreation Area (BISO): 2018 Fire Effects Monitoring Annual Report

Activity Summary

During 2018, the APC Zone fire effects team continued to provide fire ecology and fire effects monitoring services to BISO, although planning and operations services are now provided by the Mississippi River Fire Management Zone. Our team made two visits to BISO during 2018; the first to collect data on immediate post-burn effects of the Bald Knob (north) prescribed burn, and then later in the summer to more closely examine fire effects on vegetation in Bald Knob. The burn and initial monitoring work for Bald Knob are described in the “*Review of 2018 Projects*” below. The summer monitoring trip also included data collection from 10-years post-burn at Gobblers Knob.

Review of 2018 Projects

Bald Knob Prescribed Burn:

The Bald Knob (north section) prescribed burn was completed on April 13, 2018. This is the third time that the 1029-acre unit has been burned since 2006. The last burn occurred in April 2011, and a detailed report of that burn and the overall condition of the unit was included in the 2011 Fire Effects Monitoring Annual Report (<https://irma.nps.gov/DataStore/Reference/Profile/2221444>). The 2018 burn was implemented by staff of the MS River Fire Management Zone, Big South Fork NRRRA, Cumberland Gap NHP, and the SER Fire Management Office.

The resource objectives (*from the Incident Action Plan*) for the 2018 burn were:

- Reduce total fuel loading from pre-burn levels by >40% measured immediately post-burn
- Reduce mean density of pole-size trees by >30% within 1 year post burn
- Limit overstory mortality to <20% as measured 1 year post burn.

No on-site weather conditions were reported, but the NWS Spot Forecast predicted conditions that were warm (80F high), dry (25% rh), and breezy (south winds to 15mph, gusting to 25), with good dispersion (ADI 54, vent rate >72,000). Very few observations of fire behavior were reported, but accounts seem to indicate that fire behavior was fairly active in the interior, with a mix of fire spread types and occasional torching of holly and mountain laurel resprouts.

Two permanent monitoring plots were installed in the north section of Bald Knob prior to the 2006 prescribed burn. Both plots were revisited immediately after the 2018 burn (to measure fuel consumption, tree char, and severity), and again during the summer (to measure vegetation change). Both plots are located within the Mixed oak/Heath Forest Type (CEGL 8521), which is

the dominant vegetation type of the BISO uplands. **Table 1** provides fire effects data for the 2018 burn and overall trends for resource-objective variables from Bald Knob north. Based on field surveys, these plots seem to be reasonable representations of fire effects in dry oak forests of the Bald Knob landscape for these burns. These data are not representative of pine-beetle-kill sites or other vegetation types.

Table 1. Fire Effects at Bald Knob: 2006 – 2018. (n=2, except where noted)

	Substrate Severity*	Litter Load Change	Duff Load Change	Woody Fuel Load Change	1000-hr Fuel Load Change	Total Fuel Load Change	Pole Tree Density Change	Overstory Tree Density Change
1st Burn 2006	2.4	-94%	-4%	-51%	-55%	-49%	-94%	-11%
2nd Burn 2011	3.1**	-99%**	-35%**	-54%**	-62%**	-57%**	-98%	-45%
3rd Burn 2018	2.9	-100%	-51%	+237%	+263%	+150%	-98	-67%

Note: All changes are relative to pre-burn (2005) values.

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

** n=1

The steep changes in litter fuel load (**Table 1**) are fairly typical for prescribed burns in oak forest, and the more gradual reduction in duff also follows a similar trend as other burns at BISO or other Appalachian parks. Woody fuels at Bald Knob tell a different story, which has been discussed in previous annual reports from BISO and other oak-dominated parks. Reductions of woody fuels were observed following early burns, but accumulations of new woody fuels has occurred as a result of high levels of fire-induced tree mortality. This large increase in woody fuels (particularly 1000-hr fuels) has resulted in a large net increase in total fuel loading within these sites, complicating the achievement of long term resource objectives.

This is not an isolated occurrence, and several other parks that have burned in oak-dominated forests have seen similar responses, especially following early burns that were completed in each respective park. It has been a success for NPS fire management to detect the undesirable aspects of these results, and make changes to the prescriptions and/or objectives to encourage burning practices that can help to minimize large fuel accumulations. Unfortunately, a hallmark of these high-tree-mortality early burns is: a) greater exposure to sun and drying associated with canopy loss, b) cambial damage to residual trees, and c) “jackpots” of woody fuels. These factors combine to make it much more challenging to moderate subsequent burns and prevent additional mortality among those residual trees. This helps to explain the continued increase in overstory tree mortality observed at Bald Knob.



Figure 1. Long term monitoring plot QUAL02 at Bald Knob. This photo, taken the first growing season after the 3rd entry of fire, illustrates the topkill and resprouting of a thicket in a fire-induced canopy gap.

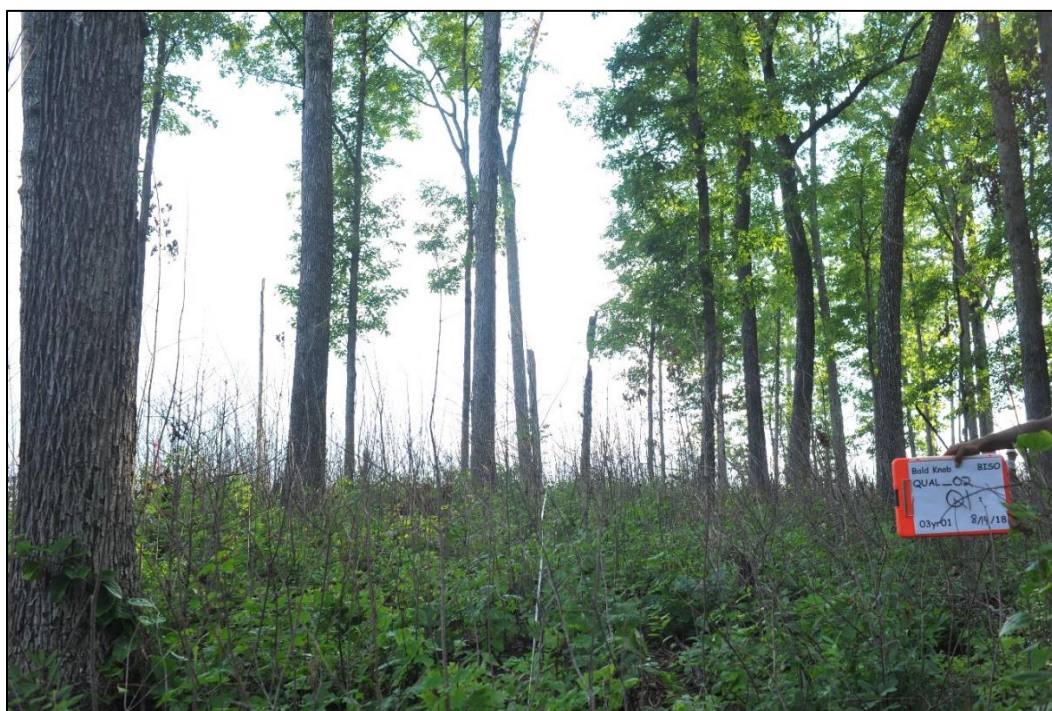
Another feature of these high-mortality burns is the release and rapid growth of resprouting woody stems (**Figure 1**). These thickets of woody regrowth often include desirable reproduction of shortleaf pine and oak species at BISO; however, monitoring data and numerous observations reveal that thickets are usually dominated by resprouts of shade tolerant species such as red maple and black gum that had become established in the midstory of oak forests during the long fire suppression period of the past 50-100 years. Clonal species, such as sumac or sassafras, also respond to increased light levels by dramatically increasing stem density on dry sites. The net effect of this rapid thicket formation is that follow-up burns must be conducted on a shorter and more rigid return interval, lest the stems in the thicket achieve a fire-resistant size. Again, efforts have been made to reduce the likelihood of this occurring on future first-entry burns.

Results of multiple burns at Bald Knob have also included desirable effects, as reported in the 2011 Annual Report. These effects that are more in line with long term restoration goals include creation of oak woodland structure (**Figure 2**), establishment of some shortleaf pine and oak reproduction, and increases in native herbaceous plant cover. Our goals for NPS monitoring include gaining greater understanding of how we can increase the attainment of desirable effects while minimizing those less desirable impacts.

Figure 2. Repeated photos of long term plot QUAL02 from 2005 (top) and 2018 (bottom).



**Preburn photo of long term monitoring plot QUAL02 at Bald Knob. August 2005.
Note the heavy growth of shade-tolerant red maple in the understory.**



Same photopoint at QUAL02 after 3 burns. August 2018. Here, prescribed burning has created a desirable woodland structure, and shading by the residual overstory trees has limited the growth rate of the resprouting woody stems of the understory. This photo pair, when coupled with knowledge of fuel load increases and thicket formation, illustrates the complex mix of results that often accompany fire restoration projects.

Long Term Monitoring Results

No updates have been made to the long term monitoring results for this report. Most of Table 2 was updated for last year's report, and no new data was collected in 2018 that would change these most recent analyses.

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

Vegetation Type	Management Objective Restoration Phase- (After 4 burns)	Monitoring Results (80% confidence intervals)	Objective Achieved?	Year Last Analysis Completed
Dry Oak Forest (FQUAL1)	>50% Reduction in total fuel loading	<u>Total fuel load change</u> After one burn (n=10): -52% ($\pm 3\%$) After 2 burns (n=8): -43% ($\pm 7\%$) After 3 burns (n=3): 46% ($\pm 27\%$)	Insufficient data. Trends need to be reexamined.	2018
14 plots - <i>11 have burned once</i>	>70% Reduction in pole-sized tree density ($\leq 15\text{cm dbh}$)	<u>Pole reduction</u> After one burn (n=10): 62% ($\pm 11\%$) After 2 burns (n=4): 93% ($\pm 10\%$) After 3 burns (n=2): 69% ($\pm 27\%$)	Insufficient data, but the trend is very positive	2018
<i>5 have burned twice (3 Fuel Transects have also burned twice)</i>	20-40% Reduction in overstory tree density ($>15\text{cm dbh}$)	<u>Overstory reduction</u> After one burn (n=11): 5% ($\pm 3\%$) After 2 burns (n=5): 36% ($\pm 17\%$) After 3 burns (n=3): 28% ($\pm 40\%$)	Insufficient data, but the trend is very positive	2018
<i>5 have burned three times</i> <i>3 remain unburned</i>	>200 tall ($>1\text{m}$) Oak seedlings /ac	<u>Oak Seedlings:</u> Preburn (n=11): 199/acre (± 162) After 1 burn (n=11): 537/acre (± 276) After 2 burns (n=5): 1020 (± 545) After 3 burns (n=3): 1161 (± 334)	Insufficient data, but the trend is very positive. Objective may need to be revised.	2018
	>30% Cover by native herbs	After 1 burn: 14% (± 5) (n=11 plots)	Insufficient data.	2012
Little Bluestem Sandstone Glade (FSCSC1)	>70% Reduction in pole-sized tree density	<u>Pole reduction:</u> After 1 burn (n=3) = 14% ($\pm 16\%$) After 2 burns (n=3) = 29% ($\pm 23\%$) After 3 burns (n=3) = 34% ($\pm 23\%$) After 4 burns (n=2) = 35% ($\pm 20\%$)	Insufficient data, but the trend is very positive. Objective may need to be revised.	2018
3 plots- <i>3 have burned four times</i> <i>1 has burned three times</i>	>100% Cover by native herbs	Preburn cover: 98% (± 26) After 1 burn: 123% (± 28) After 2 burns: 133% (30) (n= 3 plots)	Insufficient data.	2011

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

Blue Ridge Parkway (BLRI): 2018 Fire Effects Monitoring Annual Report

Activity Summary

No prescribed burns were completed at BLRI during 2018. Consequently, the Appalachian-Piedmont fire effects monitoring team did not complete any field monitoring at BLRI, though the Fire Effects Crew Leader and Assistant Lead assisted with providing annual firefighter refreshers for Parkway staff. Field work during 2019 will be contingent on plans to conduct additional prescribed burning or fuels reduction projects.

Additional data management work was completed in 2018 to support monitoring and analysis of the 2016 Air Bellows prescribed burn, and a summary of the fire effects data from that burn can be found below.

Fire Effects Data Summary for 2016 Air Bellows Prescribed Burn:

The Air Bellows prescribed burn was conducted on March 9, 2016 by fire managers from the National Park Service, North Carolina Wildlife Resources Commission, and North Carolina State Parks. The unit lies within Alleghany and Wilkes counties in North Carolina, and is situated at approximately Milepost 238 along the Parkway.

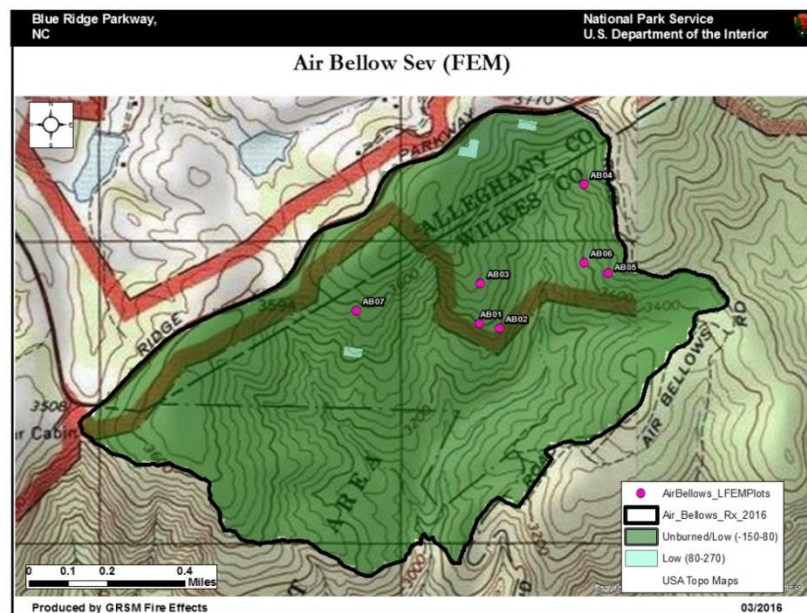


Figure 1. Burn severity mapping (dNBR) of the Air Bellows Prescribed burn, with permanent plot locations. This product of remote sensing illustrates the uniformly *low severity* burn of March 9, 2016.

A description of the burn day weather conditions was provided in the 2016 Annual Report: <https://irma.nps.gov/DataStore/Reference/Profile/2221444>. Overall, mild weather conditions coupled with low-intensity ridgetop ignition resulted in a uniformly low-severity burn (**Figure 1**). The remote-sensing map of burn severity is supported by plot-based monitoring conducted before and after the prescribed burn, which recorded a “light” severity on the forest floor and a modest (17%) decrease in the total fuel loading (**Table 1**). Such modest total fuel reduction is typical for first-entry dormant-season burns in Appalachian hardwood forests, and this result is supportive of the achievement of long term objectives for these forests. The heaviest fuel loading in these forests is found in the duff layer, which retains high levels of moisture during the cool, moist conditions of late winter and early spring. Results from past burns and wildfires suggest that total fuel/duff reduction is best accomplished gradually, to avoid excessive mortality of the forest overstory.

Table 1. Mean fuel loading before and after the Air Bellows burn, and percent change. (n=7)

	Substrate Severity*	Fuel Load: Litter (tons/ac)	Fuel Load: Duff (tons/ac)	Fuel Load: 1000-hr (tons/ac)	Fuel Load: Total Fuel (tons/ac)
Preburn		2.1	9.0	1.6	14.1
Post Burn	3.0	0.2	7.6	1.5	11.6
% Change		-88%	-16%	-7%	-17%

*Severity is rated for 40 points in each plot and averaged. Scale of 1-4; 1=high, 2=moderate, 3=light, 4=scorch, 5=unburned.

Fire Effects on vegetation were recorded from 7 permanent plots within the Air Bellows burn unit, and these results support the assessment of Air Bellows as a low-severity understory burn (**Table 2**). There was little impact to mature trees (upper canopy + intermediate), while good reductions in cover were observed in the tall shrub stratum. Cover reduction in the tall shrubs were largely driven by branch reduction and stem topkill of Mountain Laurel (*Kalmia latifolia*) (see **Figures 2 & 3**) in multiple plots. Small increases in mean cover of the herb layer were driven by a large single-plot increase in Hay-scented fern (*Dennstaedtia punctilobula*) and overall increases in Mountain Laurel, as that shrub resprouted following fire-induced topkill.

Table 2. Mean vegetation cover before and first growing season after the Air Bellows burn. (n=7)

	Upper Canopy Cover	Intermediate Tree Cover	Tall Shrub/ Short Tree Cover	Herb Layer Cover
Preburn	68%	47%	70%	80%
Post Burn	70%	47%	48%	95%
% Change	+3% (no change)	no change	-31%	+20%



Figure 2. Plot AB001. Preburn.



Figure 3. Plot AB001. 1 year postburn.

Note the intact canopy and greatly reduced cover of Mountain Laurel in the tall shrub layer.

Cape Hatteras National Seashore (CAHA): 2018 Fire Effects Monitoring Annual Report

Activity Summary

No prescribed burns were completed at CAHA during 2018, though several mechanical fuel reduction projects were completed, and the APC Zone Fire Effects crew provided training and monitoring support during two visits. Early in the year, the Lead and Assistant Lead Monitors assisted in providing annual firefighter refreshers for Seashore staff. Dodging Hurricanes Florence and Michael, the Fire Effects crew made a trip to the Seashore in October to complete year-5 postburn sampling of long-term monitoring plots in the Bodie Island 1.3 burn unit. Additional work also included: installing more salt-resistant plot markers in units 1.3, 1.4, and 1.8; photo-monitoring of mechanical fuels reduction at Bodie Island, Hatteras Island, Fort Raleigh, and Wright Brothers; and meeting with Seashore managers to discuss vegetation conditions and long-term fire management goals. Summaries of prescribed-burn monitoring can be found in the following section of this report, while reporting on results of mechanical fuel reductions will be included in next year's Annual Report.

Review of 2018 Monitoring

Year-5 Postburn Monitoring of Bodie Island 1.3:

The Bodie Island 1.3 prescribed burn was conducted in 2014, and initial monitoring was completed during the summers of 2014 and 2015. The burn objectives and initial findings were provided in the 2015 Annual Report, which can be found here:

<https://irma.nps.gov/DataStore/Reference/Profile/2221444>.

In the fall of 2018, the monitoring crew returned to complete the year-5 resampling of 12 permanent plots. Each plot is marked by a single center stake, and features four repeated photos, and dominant-species cover estimates within a 5-m radius area around the center point. Center stakes for all plots were metal conduit, but were replaced in 2018 with higher visibility, salt-resistant PVC. Goals for monitoring include: determination of whether objectives for shrub reduction and herbaceous cover are being met, and detecting fire-related changes to populations of invasive plants – most notably *Phragmites australis*.

Initial monitoring found that the 2014 burn had been successful at reducing shrubs, but that most of the top-killed shrubs had resprouted quickly following the burn. During year-5 monitoring, many of those resprouting shrubs appeared to have re-attained much of their Preburn height and cover. The photo-series from Plot 22 (**Figures 1**) illustrates this post-fire regrowth quite well, and this regrowth was widely observed during monitoring field work. As suggested in the



**Photo 1: Preburn
10/17/12**



**Photo 2: Year 1 Post-burn
6/4/14**



**Photo 3: Year 5 Post-burn
10/16/18**

Figure 1. Plot 22, showing Preburn stature, high levels of initial top-kill at Year 1 Post-burn, and regrowth of shrubs after 5-years.

2015 Annual Report, any sustained reduction of shrub abundance in the Bodie Island marshes will require frequent, repeated burning. Based on the observed re-growth of the shrubs, the most effective strategy would likely involve burning every 1-3 years.

Vegetation sampling at each plot is designed to detect broad changes to the most abundant species, which provides a way to determine if objectives for herbaceous species are being met, and simultaneously detect if negative trends such as *Phragmites* expansion are occurring. **Table 1** provides average cover values over time for all herbaceous species combined, and for the four most abundant individual species.

Table 1. Average percent cover for the most abundant marsh species.

	Average Herbaceous Cover* (n=12)	Average Cover <i>Spartina patens</i> (n=12)	Average Cover <i>Juncus roemarianus</i> (n=12)	Average Cover <i>Typha spp.</i> (n=12)	Average Cover <i>Schoenoplectus spp.</i> (n=12)
Preburn 2012	81%	17%	20%	16%	10%
Year 2 Post-Burn 2015	148%	43%	22%	28%	19%
Year 5 Post-Burn 2018	165%	42%	24%	27%	29%

*Only includes species with >5% cover

The average cover of all herbaceous species having greater than 5% cover increased following the 2014 burn, and those increases have been maintained and have even slightly increased through year 5 post-burn. The overall increase reflects substantial increases in several of the most abundant marsh species (*Spartina patens*, *Typha spp.*, and *Shoenoplectus spp.*). Conversely, cover of black needle-rush (*Juncus roemarianus*) has remained fairly stable over that same time period, which seems to be the most common response of the species to burning. It should certainly be pointed out that while changes to vegetation cover such as these are commonly reported following burns, the sampling design does not control for other factors such as annual rainfall, temperature, or saltwater intrusion. Each of these factors (and others) may be contributing in various ways to observed trends in vegetation.

Repeated photos and plant cover data provide evidence that *Phragmites australis* has also increased in areas where it was already established prior to burning. **Figure 2** is a photo series



**Photo 1: Preburn
10/17/12**



**Photo 2: Year 2 Post-burn
9/24/15**



**Photo 3: Year 5 Post-burn
10/16/18**

Figure 2. Plot 26, showing increase in *Phragmites* following prescribed burning.

from plot 26 that vividly illustrates increases in *Phragmites* abundance in the years since the 2014 burn. Plot cover data (**Table 2**) provides strong evidence for an average seven-fold increase in cover of *Phragmites* across all plots. It's important to understand that plots containing no *Phragmites* prior to burning still have no incidence of the plant 5 years after burning. This is likely due to the clonal nature of the species, and its localized, vegetative mode of spreading.

Table 2. *Phragmites australis* cover in Bodie Island 1.3 monitoring plots. Plots not listed contained no *Phragmites* during any sampling visit.

	Pre-Burn Cover (%)	Year 2 Post-Burn Cover (%)	Year 5 Post-Burn Cover (%)
Plot 17	15	15	87.5
Plot 20	15	15	62.5
Plot 21	2.5	15	62.5
Plot 26	2.5	37.5	37.5
<i>Average % Cover (n=12)</i>	<i>2.9%</i>	<i>7%</i>	<i>21%</i>

Conclusions

Results from six years of fire effects monitoring suggest several important things about prescribed burning of marsh habitat at CAHA:

- burning can provide an effective way to reduce shrubs in open marsh habitat
- most shrub species resprout quickly following burns; so frequent, repeated burns are necessary to maintain shrub reductions (1-3 year rotation)
- burning can contribute to increased cover and productivity by native herbaceous species
- as observed in other coastal areas, burning can also contribute to substantial, localized increases in the invasive and problematic grass *Phragmites*
- for a prescribed burning program in CAHA marshlands to be successful, it needs to be accompanied by a dedicated *Phragmites* control program.

Chickamauga/Chattanooga National Military Park (CHCH): 2018 Fire Effects Monitoring Annual Report

No prescribed burns or hazard fuel treatments were completed at CHCH during 2018, and consequently there was no field monitoring completed at CHCH during this year. However, early in the year, the Lead and Assistant Lead Monitors assisted in providing annual firefighter refreshers for CHCH staff. In October, the Park management team met with APC Zone Assistant FMO-Fuels and Fire Ecologist to discuss building a prescribed fire program. During the meeting, it was decided that the Park's primary goals were to:

- conduct burning within Chickamauga Battlefield
- restore historically appropriate vegetation structure and composition
- focus initial efforts on restoring limestone glades, which are rare natural areas where fire is recommended.

After a discussion of possible locations, the team decided on a 150-acre block off of Viniard-Alexander road in the southeastern part of the Battlefield (**Figure 1**).

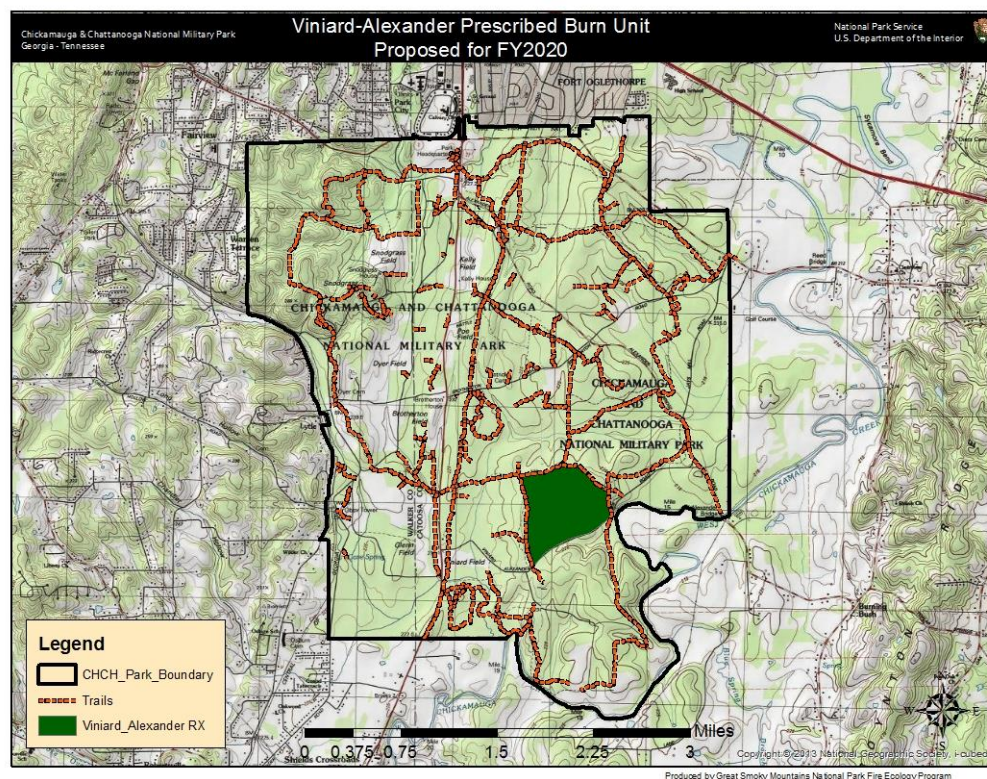


Figure 1. Location of proposed Viniard-Alexander prescribed burn unit

Monitoring Plan Development:

The APC Zone Fire Ecologist, Lead Monitor, and Assistant Lead visited the Park in February of 2019 to assist with the Firefighter Refresher, and were able to spend an additional day meeting with CHCH Ranger staff and local Ecologist Tom Govus on the site of the Viniard-Alexander unit. Mr. Govus has been involved in vegetation mapping and monitoring at CHCH for at least 13 years, and is currently contracted to survey the vegetation of the Park's major glades in 2019. Mr. Govus' 2019 work will be the second resampling of long-term monitoring plots that were originally established in 1993, and three of the glades included in those studies (Glades 13, 14, and 24) lie within the Viniard-Alexander prescribed burn unit (**Figure 2**). The existing data and 2019 surveys will be extremely useful for augmenting any long-term fire-effects monitoring.

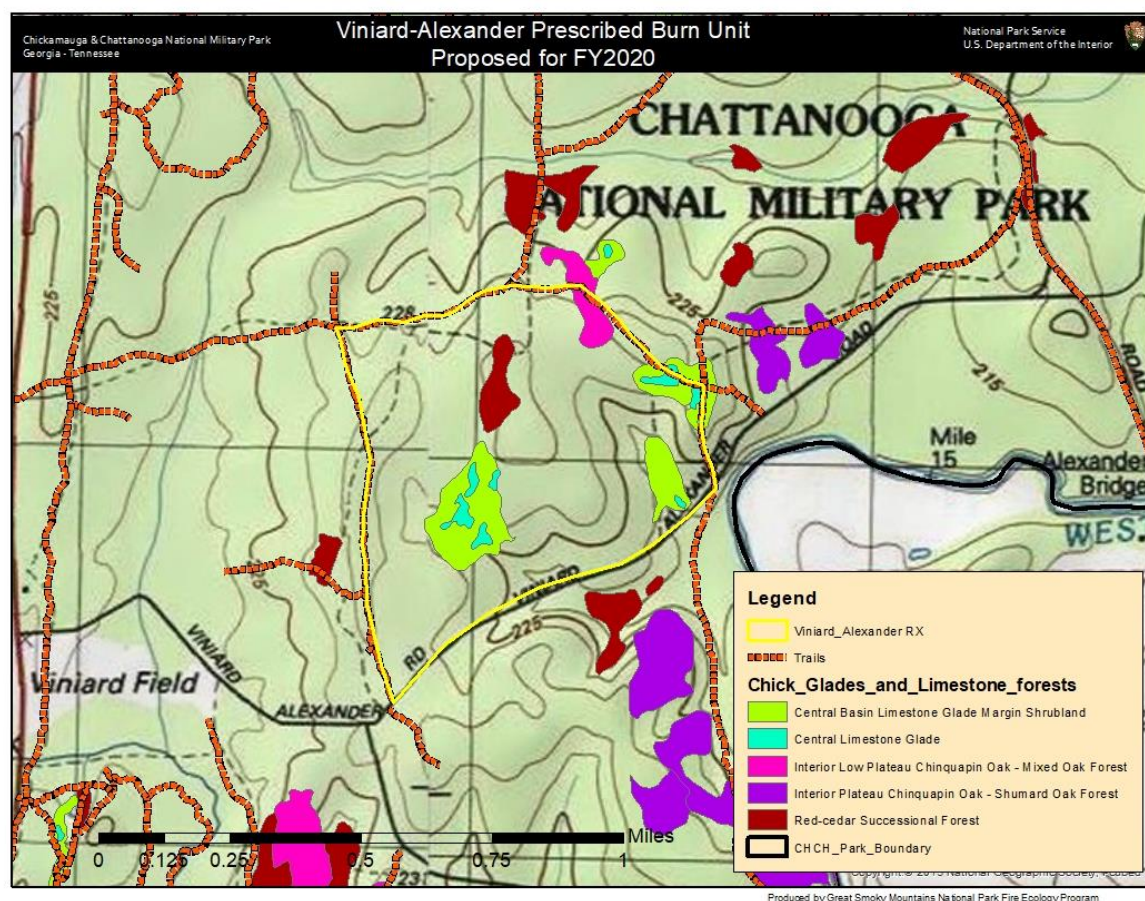


Figure 2. Major limestone glades of the Viniard-Alexander burn unit.

The majority (non-glade portion) of the unit is covered by woodlands and forests of oak, loblolly pine, and eastern red-cedar. Long-term fire-effects monitoring will combine existing NPS protocols with long-term glade monitoring data to assess progress toward meeting objectives for both glades and oak woodlands. Final sampling design will depend on specific fire/resource objectives, which are currently being developed. Plot establishment and baseline monitoring will be completed during the upcoming summer of 2019.

Possible Goals and Short-Term Objectives for Glades and Oak/Pine Woodlands at CHCH:

A. Glades

Long-term goal: Maintain or expand current areal extent and species composition of herb-dominated glades by reducing woody stem density and limiting future woody encroachment.

- a.** Burn at least 90% of herb-dominated glade area
- b.** Consume at least 80% of fine fuels over the burned area
- c.** Top-kill >40% of small woody stems (less than 2.5" dbh) within the glade perimeter

B. Oak/Pine Woodlands

Long-term goal: Restore an oak/shortleaf pine/(loblolly pine?) woodland characterized by an open canopy and midstory, adequate oak and shortleaf pine regeneration, and >30% cover of native herbaceous species.

- a.** Burn at least 70% of area currently dominated by oak, loblolly pine, or shortleaf pine
- b.** Consume at least 80% of fine fuels over the burned area
- c.** Top-kill >30% of small woody stems (less than 4" dbh) within oak and oak-pine forest

Congaree National Park (CONG): 2018 Fire Effects Monitoring Annual Report

Activity Summary

The APC fire ecology/fire-effects monitoring team made a combined three trips to Congaree during 2018. The fire effects crew participated in the March 28 prescribed burn of the Harry Hampton burn unit, and returned in May to assist with the latest burn of the RCW unit. The Ecologist and crew visited the Park in June to complete post-burn monitoring of both burns, and were assisted by Cynthia Worthington of the MS River Zone fire effects team. A brief discussion of post burn monitoring of the Harry Hampton and RCW prescribed burns can be found in the following section of this report.

Review of 2018 Projects

Harry Hampton and RCW Prescribed Burn:

The Harry Hampton unit (182 acres) was burned for the 8th time on March 28, 2018, and the RCW unit (303 acres) was burned for (at least) the 10th time on May 7, 2018 (**Figure 1**).

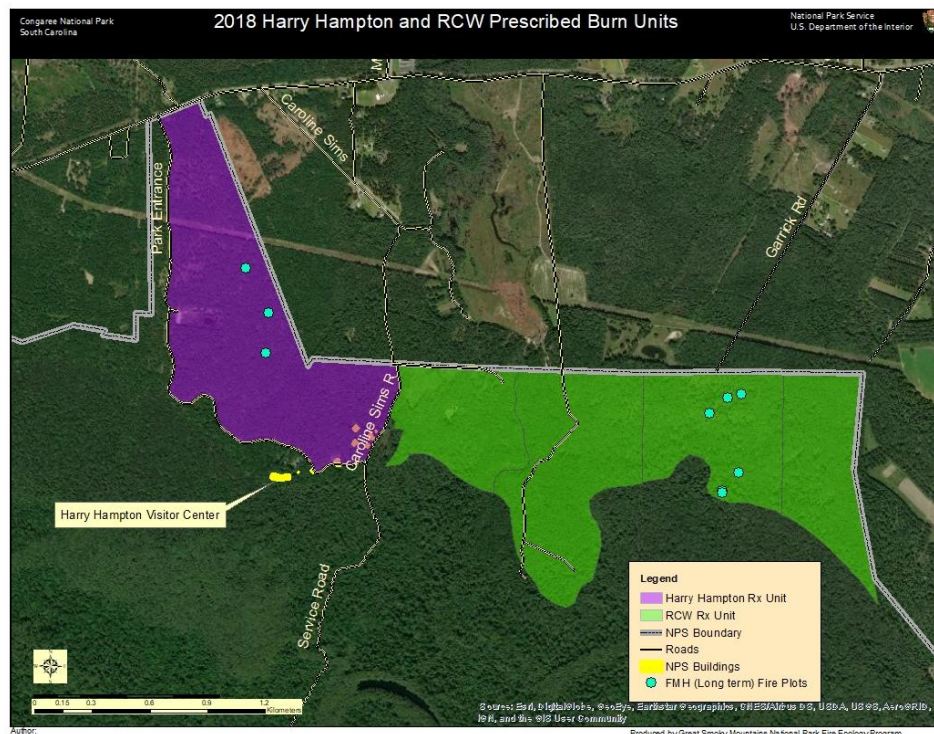


Figure 1. 2018 Harry Hampton and RCW Burn Units

No FEMO report was filed for either burn, so no weather or fire behavior information is available for this report. Several pictures were taken during and immediately after the RCW burn, and they provide some information. **Figure 2** illustrates surface fire spread and behavior that appears typical for the RCW unit. **Figure 3** illustrates immediate effects to understory



Figure 2. Fire behavior during 2018 RCW burn.

Sweet-gum clones. This level of impact to these sapling-sized trees is usually effective at top-killing the stems, which is a key objective for burns at Congaree. Finally, **Figure 4** shows the minimal amount of scorch among the pine trees of the core longleaf stand in RCW. This is indicative of a fairly low intensity understory burn.



Figure 3. Immediate post-burn scorch on understory sweet-gum clones



Figure 4. Pine canopy following the RCW burn. Minimal scorch of the overstory and midstory trees provides evidence of a fairly low intensity understory burn.

Long Term Monitoring Results

Long term monitoring results have been updated for this year's report (**Table 1**). Several key objectives have been achieved over the past 20 years of burning, though other objectives have not been met. This is most likely because the original objectives were created years ago, before Resource Managers and Fire Monitoring staff had adequate knowledge of what could be expected through multiple prescribed burns. A great deal has been learned from monitoring in that time, and better objectives can and should be created. Undoubtedly there is new research available that could also help to inform a new set of objectives. It is recommended that the Fire Ecologist and Park staff review both long and short term objectives for prescribed burning and monitoring in the coming year.

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

Vegetation Type	Management Objective Restoration Phase- After ?? burns	Monitoring Results	Objective Achieved?	Year Last Analysis Completed
Longleaf/ Loblolly Pine Woodland (FPIPA1) 5 plots	>50% Reduction in total fuel loading	Fuel reduction - 7 burns: 10% (n=4 plots, 1 burn unit)	No. The objective needs to be changed	2019
	15-30% Reduction in overstory tree density	Overstory reduction - 10 burns: 16% (n=4 plots, 1 burn unit)	Yes	2019
	>200 tall (>1m) Longleaf pine seedlings /ac	Preburn density: data not clean After 8 burns: 4/acre (n=4 plots, 1 burn unit)	No*	2019
Loblolly Pine Forest (FPITA1) 5 plots	>50% Reduction in total fuel loading	Total fuel reduction - 5 burns: 20% (n=3 plots, 1 burn unit)	No. The objective needs to be changed	2019
	>70% Reduction in pole-sized tree density	Pole reduction – 8 burns: 87% (n=3 plots, 1 burn unit)	Yes	2019
	25-50% Reduction in overstory tree density	Overstory reduction – 8 burns: 28% (n=3 plots, 1 burn unit)	Yes	2019

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

Cowpens National Battlefield (COWP): 2018 Fire Effects Monitoring Annual Report

Activity Summary

The APC Zone Fire-Effects monitoring team made a single visit to Cowpens in 2018, to map mechanical fuel reduction work along the Park's southeastern boundary (**Figure 1**). No prescribed burns are completed and there are no monitoring updates at this time. The fire ecology/fire effects team is committed to being involved in any future planning and implementation for prescribed burns or fuels reduction projects at COWP, and is prepared to conduct monitoring to support any such work. Plans for the coming year will thus be dependent upon projects completed during FY19 and the planning process for FY20 projects.

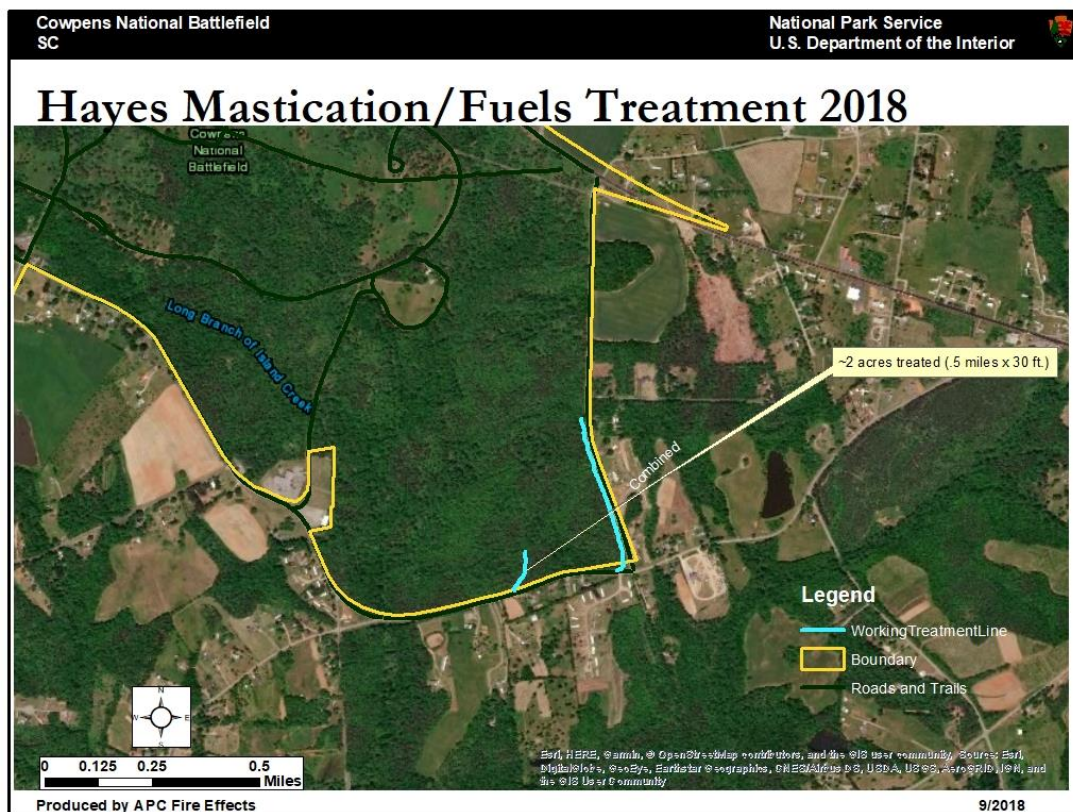


Figure 1. 2018 Boundary Fuels Reduction at Cowpens.

Cumberland Gap National Historical Park (CUGA): 2018 Fire Effects Monitoring Annual Report

Activity Summary

During 2018, the Appalachian-Piedmont fire effects team continued to provide fire ecology and fire effects monitoring services to CUGA, although planning and operations services are now provided by the Mississippi River Fire Management Zone. Our team did not conduct any monitoring during 2018, though the Fire Ecologist made a trip in March to provide Park staff with a general overview of the fire ecology at CUGA. With the completion of a prescribed burn of Harlan A in early 2019, the crew will plan to visit CUGA during the summer of 2019 to complete monitoring of long-term fire effects plots.

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.

Table 1. 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) <i>16 plots</i>	>50% Reduction in total fuel loading	Total Fuel Reduction: After 1 burn (n= <u>16</u>): 29% (± 3) After 2 burns (n= <u>11</u>): 26% (± 2)	Not yet, but on course	2013
	>70% Reduction in pole-sized tree density ($\leq 15\text{cm dbh}$)	Pole Reduction: After 1 burn (n= <u>16</u>): 39% (± 5) After 2 Burns (n= <u>11</u>): 67% (± 3)	Not yet, but close	2013
	15-30% Reduction in overstory density ($>15\text{cm dbh}$)	Overstory Tree Reduction: After 1 burn (n= <u>16</u>): 5% (± 5) After 2 Burns (n= <u>11</u>): 8% (± 1)	Not yet, but on course	2013
	>200 tall ($>1\text{m}$) Oak seedlings /acre	Preburn (n=16 plots): 101/ac (± 12) After 1 burn(n=16): 91/acre (± 6)	Not yet.	2011
	>30% Cover by native herbs	Preburn cover (n=14): 2% ($\pm 1\%$) After 1 burn (n=14): 4% ($\pm 2\%$)	No, but more burns are needed.	2011
	< 20 Invasive exotic plants/acre	Preburn avg (n=16): 0/acre Post burn mean (n=16): 20/acre (± 14)	Unclear due to high variability.	2011

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

Great Smoky Mountains National Park (GRSM): 2018 Fire Effects Monitoring Annual Report

Activity Summary

Support for the host Park in 2018 centered on continued monitoring and reporting of short and long-term fire effects of the 2016 wildfires, the prescribed fire program, and the Gatlinburg mechanical fuel reduction project. The fire effects crew completed the two-year effort to monitor the severity and effects of the 2016 Sevier County/Chimney Tops 2 wildfire with the installation of 13 additional plots. Much of the field work on this project during 2018 focused on establishment of permanent plots near the park boundary, which provides an opportunity to track vegetation and fuel recovery in the Wildland-Urban-Interface. On the prescribed fire front, the crew completed post-burn monitoring of the Little Cataloochee prescribed burn, and year-5 postburn monitoring of the Lynn Hollow unit in Blount County. The Lynn Hollow work extends the data record for that site to 20 years, as the fire program seeks to re-burn the site in 2019. Finally, the crew conducted photo-monitoring and mapping of the Gatlinburg/Ski Mountain mechanical fuel reduction project. An example of this work is featured on the cover of this year's APC Zone report, and additional information is provided in the "Review of 2018 Projects" section of this report.

Other 2018 accomplishments included:

- support and collaboration for fire-related research in the Park,
- leadership and collaboration in the formation of the GRSM Fuels Interdisciplinary Team
- strong support and participation in fire operations
- fire ecology training and information for Park staff, partners, and the public
- creation of an SOP for and completion of fire mapping and documentation.

Review of 2018 Projects

Little Cataloochee Prescribed Burn:

The second entry of fire into the Little Cataloochee burn unit was completed on April 12, 2018. Little Cataloochee is a 100-acre unit within the larger Canadian Top/Cataloochee fire management landscape, and the management goals for this area include:

- restoration of montane oak woodlands through thinning of the midstory and understory
- improvement of elk habitat by increasing herbaceous plant cover
- reduction of hazard fuels around the Little Cataloochee Church.

As with the 2010 first-entry burn, the 2018 burn was a relatively low-severity surface fire. Weather conditions were mild, and fire behavior mostly consisted of backing surface fires and isolated, short duration upslope runs resulting from a “dot” ignition pattern (**Figure 1**). Immediate postburn monitoring revealed that the burn was successful at removing the litter layer (**Table 1**), and this level of consumption was observed throughout much of the unit during postburn surveys.

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

Burn Status	1000-hr Fuel Load Change	Duff Fuel Load Change	Litter Fuel Load Change	Total Fuel Load Change	% Overstory Mortality	% Pole Mortality
2010 – After 1 Burn	-2%	-19%	-95%	-11%	No Mortality	16%
2018 – After 2 Burns	-95%*	-7%	-100%	-61%	+11%	-61%

Notes: All data compared to preburn. Reduction in 1000-hr fuels driven by the natural degradation of several large, rotten pieces of wood in the 9 years since the first burn. Change in duff reduction between burns likely also reflects this degradation of rotten fuels, as those logs turned into duff.

Further monitoring during summer 2018, revealed that the burn had no effect on overstory trees (in fact, there was a slight increase as large poles grew to overstory size), but there was a substantial reduction in pole-sized trees (**Table 1**). This result is perfectly in line with restoration objectives during first and second entry burns, and has resulted in a much more open understory within large parts of the unit and the monitoring plot (**Figure 2**). Finally, additional survey of the burn unit revealed excellent reduction of understory Mountain Laurel and white pine throughout much of the site, as well as excellent fire effects on midstory and understory red maple, which should lead to further reductions of that species over time.



Figure 1. Typical ridgetop fire behavior of Little Cataloochee Rx.



Figure 2. Repeated photo from Plot QUCO13 showing reduction of woody stems in the understory. The top photo was taken immediately following the 2010 burn, and the bottom photo was taken during the summer of 2018, following the second burn.

Ski Mountain Mechanical Fuel Reduction:

Mechanical fuel reduction along the Park boundary with Gatlinburg/Chalet Village was a major accomplishment of the APC Zone during 2018. The project used a Caterpillar skid-steer with a masticating head to clear understory trees and shrubs within a 30' wide swath along the Park boundary. This action greatly reduces fire intensity in the event of a wildland fire by effectively removing “ladder” fuels and “jackpots” of woody fuels. **Figure 3** shows where the work was completed during two separate weeks during 2018. Gaps in the treatment line represent areas that were inaccessible to the skid-steer. Additional work may be needed to assess the fuels risk and reduce fuel hazards in these areas.

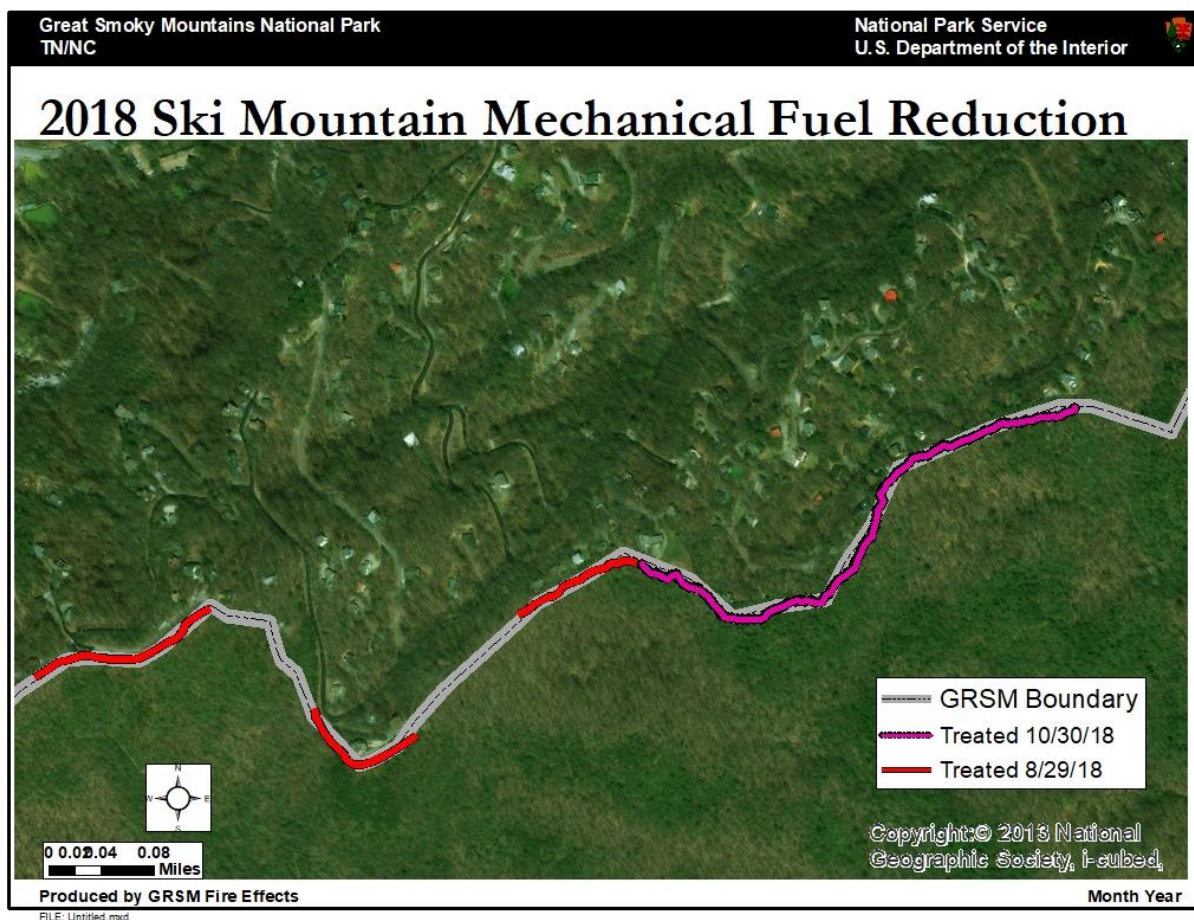
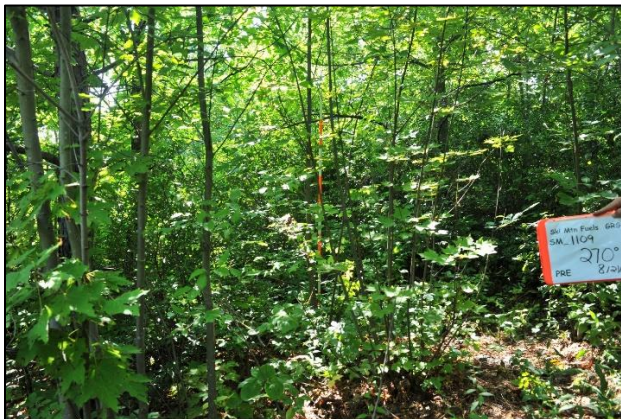


Figure 3. Map of completed sections of 2018 mechanical reduction along GRSM-Gatlinburg boundary.

Photo-points were established just prior to the treatment, and photos were taken before and after the treatment to monitor and document the results of this project. **Plates 1 and 2** below provide some of the highlights from the monitoring effort. The photo-pairs clearly show dramatic changes in live fuels immediately following the thinning. Photo-points will be repeated on an annual basis to provide updates on fuel recovery to Park and Fire managers.

PRE



POST



Plate 1. Before and after photos of Ski Mountain mechanical fuel reduction. Photos on the left are Pre-Treatment and photos on the right are the same view Post-Treatment.

PRE



POST



Plate 2. Before and after photos of Ski Mountain mechanical fuel reduction. Photos on the left are Pre-Treatment and photos on the right are the same view Post-Treatment.

Long Term Monitoring Results

No updates have been made to the long term monitoring results for this report. Most of Table 2 was updated for last year's report, and no new data was collected in 2018 that would change these most recent analyses.

Table 2. 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) <i>29 Total Plots :</i> <i>28 have burned once</i> <i>17 have burned twice</i> <i>5 have burned three times</i> <i>1 remains unburned</i>	>50% Reduction in total fuel loading	Total fuel reduction: After 1 burn (n=27): 34% ($\pm 7\%$) After 2 burns (n=16): 37% ($\pm 6\%$) After 3 burns (n=5): 15% ($\pm 26\%$)	Insufficient data. <i>Objective may need to be revised.</i>	2018
	>70% Reduction in pole-sized tree density	Pole reduction: After 1 burn (n=28): 51% (± 8) After 2 burns (n=15): 77% (± 6) After 3 burns (n=5): 60% (± 27)	Insufficient data. But trend is positive.	2018
	25-50% Reduction in overstory tree density	Overstory reduction: After 1 burn (n=28): 18% (± 7) After 2 burns (n=15): 50% (± 13) After 3 burns (n=5): 10% (± 18)	Insufficient data.	2018
	>200 tall (>1m) Yellow Pine seedlings /ac	Yellow Pine Seedling Density: Preburn density (n=28): 0 After 1 burn (n=24): 631/ac (± 300) After 2 burns (n=15): 1237/ac (± 849) After 3 burns (n=5): 130 (± 198)	Insufficient data. But trend is positive. High variability.	2018
	>40% Cover by native herbs/subshrubs	Preburn cover: 3% ($\pm 1\%$) (n=23) After 1 burn (n=23): 11% ($\pm 4\%$) After 2 burns (n=9): 10% ($\pm 6\%$)	Insufficient data.	2009
Dry Oak Forest (FQUCO1) <i>24 total Plots :</i> <i>17 have burned once</i> <i>10 have burned twice</i> <i>5 have burned three times</i> <i>7 remain unburned</i>	>50% Reduction in total fuel loading	Total Fuel reduction: After 1 burn (n=15): 29% (± 4) After 2 burns (n=7): 27% (± 17) After 3 burns (n=5): 26% (± 18)	Insufficient data. <i>Objective may need to be revised.</i>	2018
	>70% Reduction in pole-sized tree density	Pole reduction: After 1 burn (n=17): 45% (± 10) After 2 burns (n=9): 49% (± 13) After 3 burns (n=5): 77% (± 16)	Insufficient data. But trend is positive.	2018
	15-30% Reduction in overstory tree density	Overstory reduction: After 1 burn (n=17): 5% (± 5) After 2 burns (n=9): 9% (± 11) After 3 burns (n=5): 7% (± 11)	Insufficient data.	2018
	>200 tall (>1m) Oak seedlings /ac	Oak Seedling Density: Preburn density (n=17): 71 (± 66) After 1 burn (n=17): 229/ac (± 180) After 2 burns (n=9): 279/ac (± 152) After 3 burns (n=5): 16 (± 25)	Insufficient data. But trend is positive. High variability.	2018
	>30% Cover by native herbs/subshrubs	Preburn cover (n=9): 4% ($\pm 2\%$) After 1 burn (n=9): 4% ($\pm 2\%$)	Insufficient data.	2011

Kings Mountain National Military Park (KIMO): 2018 Fire Effects Monitoring Annual Report

Activity Summary

The fire ecologist and fire effects team made two trips to KIMO in 2018. All participated in the May prescribed burn of North Brushy, which was the fourth entry of fire into this unit. Everyone returned in September to conduct year-1 post burn monitoring of that unit, and plot sampling was also completed in the Piedmont burn unit. A summary of the prescribed burn and monitoring completed at North Brushy can be found in the “Review of 2018 Projects” section below.

Review of 2018 Projects

North Brushy Prescribed Burn:

The North Brushy prescribed-burn was completed on May 3, 2018 (**Figure 1**). This was the fourth entry of prescribed fire into this unit since 2003, representing a mean fire interval of 4 years. The combination of that fire frequency with 4 burns makes North Brushy somewhat unique (along with KIMO-Saddleback) within the NPS Appalachian Highlands, and data from this leading edge of fire restoration can help to build understanding of the successes and failures in long-term fire effects. This understanding can be used to improve future operations at KIMO, and at numerous other locations with similar fuels, vegetation, and topography. To gain this long-term data, five permanent monitoring plots were installed within the unit in 2002; fire effects on fuels and vegetation were sampled immediately after the burn, and additional data were collected late in the 2018 growing season.

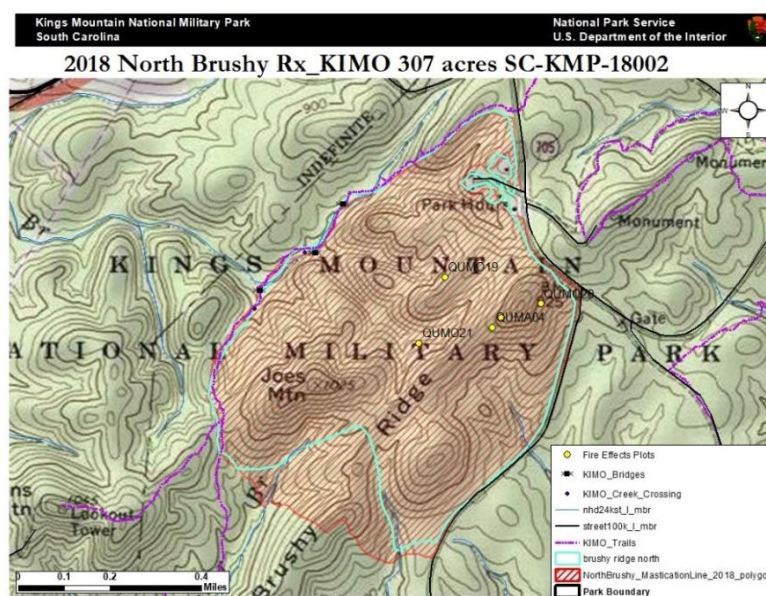


Figure 1. North Brushy Prescribed Burn Unit with monitoring plots.

The FEMO report filed for the burn indicates a warm, moderately dry day (85F, rh39%) with good ventilation (73000). Fire behavior was very active and variable, with some isolated flanking or head-fire runs (flame lengths 3-6'), but in general was very low in intensity (flame lengths 1-2') (**Figure 2**).



Figure 2. Typical low-intensity backing fire behavior observed the North Brushy burn.

Severity and fuels were re-measured in all five plots approximately 2 weeks after the burn, and the crew returned in September to monitor tree mortality and health. Three of the long-term monitoring plots are placed within the dry-oak forest that covers most of the North Brushy burn unit, while 2 additional plots are placed within the more rare Blackjack Oak rocky woodland vegetation type. All plots were resampled, but only results from the chestnut oak forest are presented in this report (**Table 1**).

Average substrate severity scores for the 2018 burn (3.5) indicate very-low-severity impacts to soils, rock, and forest floor fuel consumption, which is typical for low-intensity spring burns (see **Figure 2**). Litter consumption was quite high (-96%) during the burn, which again is a typical effect of prescribed burns in oak forests. Gradual removal of the compact, moisture-rich duff is highly desirable fire effect, and has contributed to an observed increase in grasses and pine regeneration in the unit. Duff is typically the heaviest fuel type in Appalachian oak forests, so the strong reductions in the duff layer are correlated with the strong reductions in total fuels observed over the past 15 years.

Increases in 1000-hr fuels may seem non-intuitive, however there was a very low load of these woody fuels prior to burning, and just a small *actual* increase after the first burn resulted in a large *percent* increase. In fact, it is likely that this increase is due to a non-fire factor like storm

damage or natural tree death. Finally, 1000-hr fuels are not usually reduced during spring prescribed burns due to their maintenance of high fuel moisture during this time of year.

Table 1. Fire Effects at North Brushy Dry Oak Forest Plots: 2002 – 2018. (n=3)

	Substrate Severity*	Litter Load Change	Duff Load Change	1000-hr Fuel Load Change	Total Fuel Load Change	Midstory Tree Density Change	Overstory Tree Density Change
1st Burn 2003	4.3	-26%	-8%	+216%	+14%	-13%	0
2nd Burn 2008	3.3	-94%	-35%	+220%	-24%	-32%	-5%
3rd Burn 2011	3.8	-90%	-62%	+180%	-43%	-49%	-13%
4th Burn 2018	3.5	-96%	-74%	+366%	-41%	-55%	-13%

Note: All changes are relative to pre-burn (2002) values.

*Severity is rated for 40 points in each plot and averaged. Scale of 1-5; 1 = highest severity and 5= unburned.

Finally, the repeated very-low severity burns recorded in these plots had lower than expected impacts to the midstory and overstory trees. While the reductions in these plots have not been sufficient to allow fundamental changes in herbaceous species abundance or oak/pine regeneration within these plots, the avoidance of large areas with a high level of tree mortality has prevented the more negative effects associated with thicket formation and large accumulations of heavy fuels seen in more severely burned parts of KIMO.

In addition, survey-style monitoring of the entire North Brushy burn unit revealed a much broader range of effects than what can be observed in the long-term plots. This includes multiple areas where small patches of understory and/or overstory trees have been killed by fire, and where grasses and pine/oak seedlings have been able to re-establish (**Figures 3 and 4**). Taken as a whole, these effects illustrate the promise of prescribed burning in oak/shortleaf pine ecosystems, but also the long-term nature of landscape-scale restoration projects.



Figure 3. Survey site within North Brushy showing a small, fire-created canopy opening.



Figure 5. Survey site in North Brushy showing a small canopy opening populated by Little Bluestem, Bracken Fern, Anise-scented goldenrod, and shortleaf pine seedlings.

Long Term Monitoring Results

No updates have been made to the long term monitoring results for this report. Most of **Table 2** was updated for last year's report, and there was not enough new data collected in 2018 to make a substantial update to these most recent analyses.

Table 2. 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
Dry Oak Forest (FQUM01) <i>21 plots:</i> <i>20 have burned once</i> <i>19 have burned twice</i> <i>17 have burned 3 times</i> <i>9 have burned 4 times</i>	>50% Reduction in total fuel loading	Total fuel reduction: After 1 burn (n=19): 40% ($\pm 6\%$) After 2 burns (n=18): 46% ($\pm 5\%$) After 3 burns (n=17): 57% ($\pm 5\%$) After 4 burns (n=7): 61% ($\pm 6\%$)	Trends suggest that the objective is being accomplished after 3 burns	2018
	>70% Reduction in pole-sized tree density	Pole reduction: After 1 burn (n=20): 42% (± 9) After 2 burns (n=17): 58% (± 8) After 3 burns (n=15): 71% (± 7) After 4 burns (n=5): 76% (± 12)	Insufficient data. But trend is positive.	2018
	15-30% Reduction in overstory tree density	Overstory reduction: After 1 burn (n=20): 7% (± 4) After 2 burns (n=17): 11% (± 5) After 3 burns (n=17): 21% (± 7) After 4 burns (n=6): 26% (± 16)	Insufficient data. But trend is positive.	2018
	>200 tall (>1m) Oak seedlings/acre	Oak Seedling Density (stems/acre): Preburn density (n=15): 183 (± 132) After 1 burn (n=20): 77/ac (± 47) After 2 burns (n=17): 233/ac (± 171) After 3 burns (n=16): 182 (± 137)	Insufficient data. High variability. Objective needs to be revised to include shortleaf pine seedlings.	2018
	>15% Cover by native herbs/subshrubs	Preburn cover (n=19): <1% After 1 burn (n=19): 1% After 2 burns (n=19): 1-2%	No, but more burns are needed.	2009
Chestnut Oak-Blackjack Oak Woodland (FQUMA1) <i>8 plots</i>	>50% Reduction in total fuel loading	Total fuel reduction: After 1 burn (n=7): 47% ($\pm 4\%$)	Insufficient data.	2009
	>70% Reduction in pole-sized tree density	Pole reduction: After 1 burn (n=8): 45% ($\pm 12\%$) After 2 burns (n=4): 62% ($\pm 12\%$)	Insufficient data.	2009
	15-30% Reduction in overstory tree density	Overstory reduction: After 1 burn (n=8): 30% ($\pm 11\%$)	Insufficient data.	2009
	>30% Cover by native herbs	Preburn cover (n=7): 6% Cover after 1 burn (n=7): 9%	Insufficient data.	2009

Moore's Creek National Battlefield (MOCR): 2018 Fire Effects Monitoring Annual Report

Activity Summary

The fire effects crew made only one visit to MOCR during 2018. Crew member Allyson Arulanantham participated in the “Savanna” and “Southwest” prescribed burns and prepared a FEMO report of the event. A trip to monitor those burns and the overall prescribed fire program in September had to be cancelled due to Hurricane Florence.

Review of 2018 Projects

Savannah and Southwest Prescribed Burns:

Thirty eight acres were burned at Moore's Creek National Battlefield (MOCR) on March 29, 2018. Two units were burned: the Savannah unit (12 acres) and the Southwest unit (25 acres). Note: the Southwest unit is a combination of two previous units, South and West. The Savannah unit was last burned in 2017 and the Southwest unit was last burned in 2016.

Table 1: From 1989 to 1995, burns were conducted by the State. Beginning in 2010 to present, burns are conducted by the NPS.

Date	Unit(s)	Acreage
March 8, 1989	Savannah	3
March 19, 1990	Savannah	5
April 9, 1991	Savannah	3
March 9, 1992	Savannah	3
March 1, 1993	South and Savannah	5
February 24, 1995	Wildfire	0.1
March 17, 2010	Savannah	4.5
February 10, 2012	Savannah	12
April 22, 2014	Savannah, South and West	24
April 21, 2016	Savannah, South and West	37
April 11, 2017	Savannah, North and East	42
March 29, 2018	Savannah and Southwest	37

The Savannah unit can be described as a wet pine savanna that has standing water throughout the year. Several native grass species were planted in the Savannah as part of restoration efforts. There are also several small longleaf pines (*Pinus palustris*) scattered throughout the unit. The park would like to maintain this unit as an open field/savannah. The Southwest unit is a combination of a mixed hardwood community and an upland pine community. Located in the Southwest unit is a small population of Atlantic White Cedars (*Chamaecyparis thyoides*) that the park is interested in preserving. Both the Savannah and the Southwest units have invasive woody shrubs. Goals for utilizing fire at MOCR include reducing hazardous fuels as the park is located

near a wildland urban interface area, restoring fire dependent vegetation such as longleaf pines and maintaining the historic landscape to preserve the features of a colonial era battle landscape.

Objectives

The objectives for the March 29, 2018 burn are listed below:

1. Use low intensity fire in areas where Atlantic White Cedar are present
2. Reduce overstory/midstory vegetation density by 40-70%
3. Reduce litter load by >70% in over >75% area of target vegetation
4. Reduce woody encroachment in Savanna unit by >50%
5. In the long term, reduce overstory by 15-30% without creating large gaps in the canopy

The eight Atlantic White Cedars were prepped around with a weed eater and a leaf blower to ensure that they did not have fire near the base of them.

Before:



After:



The Savannah unit was burned first beginning at approximately 10:45am. Igniters began with a test fire in the Northeastern corner of the Savannah unit (~150m down History Trail from the Visitor Center). They lit around the unit in both directions from the test fire, ringing the unit. Fire intensity was low in the wooded areas of the unit and increased to moderate intensity as fire reached the dry grasses of the Savannah. The unit burned patchy as several areas had standing water and/or had not dried out.



Patchy burning of Savannah unit

The following series of photos contain pre-burn and post-burn images taken at the same location.

Pre-burn Savannah photo from 2010. Unit had not had fire since 2004.



Pre-burn photo of Savannah from 2014. Taken two years after the March 13, 2010 burn in unit.



Post-burn photo of Savannah unit after April 22, 2014 burn. Taken after the third prescribed burn in unit conducted by NPS.



Post-burn photo of Savannah unit after March, 29, 2018 burn. Taken after the sixth prescribed burn in the unit conducted by NPS.



Were the objectives met?

1. Use low intensity fire in areas where Atlantic White Cedar are present
Objective met.
2. Reduce overstory/midstory vegetation density by 40-70%
Objective met as a result of several burns (See photos)
3. Reduce litter load by >70% in over >75% area of target vegetation
Objective met
4. Reduce woody encroachment in Savannah unit by >50%
Objective met as a result of several burns (See photos)
5. In the long term, reduce overstory by 15-30% without creating large gaps in the canopy
Objective met as a result of several burns (See photos)

Additional Program Information

Table 1. Planning - 2018

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 2018)	Assisted with how many BAER plans in 2018?
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 - 2018

Park	% 2018 Data entered	%2018 Data Quality Checked	# of Prescribed Fires Monitored	# Non-Fire Fuels Treatments Monitored	#Wildfires Monitored	#BAER Treatments Monitored
BISO	100	100	1	0	0	0
BLRI	100	100	0	0	0	0
CAHA	100	100	2	4	0	0
CONG	100	100	2	0	0	0
COWP	n/a	n/a	0	0	0	0
CUGA	n/a	n/a	0	0	0	0
GRSM	100	100	2	1	1	0
KIMO	100	100	1	0	0	0
MOCR	n/a	n/a	1	0	0	0

Table 3. Communicating Results - 2017

Park	# of Project Monitoring Reports completed in 2017	# of Annual meeting(s) with Park staff	# of Formal presentations of results	Do you use Minitab?*
BISO	1	0	0	Yes
BLRI	1	1	0	Yes
CAHA	1	1	0	Yes
CONG	2	1	0	Yes
COWP	0	0	0	No
CUGA	0	0	0	Yes
GRSM	2	1	0	Yes
KIMO	1	1	0	Yes
MOCR	1	0	0	No

Table 4. Research - 2017

Park	Are research needs identified in FMP or Monitoring Plan? (yes or no)	# of Proposals Submitted in 2018	# of Proposals Funded in 2018	# of Research Projects Supported in 2018*	Additional Comments
BISO	yes	0	0	1	
BLRI	yes	0	0	0	
CONG	yes	0	0	0	
COWP	yes	0	0	0	
CUGA	yes	0	0	0	
GRSM	yes	2	1	6	
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 2018 Accomplishments/Focus Areas

Category	Percent Time	Accomplishments and/or areas of activities
Data Collection	15%	Field work at GRSM, KIMO, CAHA. FMH plots, LFEM plots, Photo-monitoring, and qualitative surveys.
Planning	15%	Fire effects program planning. APC Zone planning (senior staff discussions) . Fuels program planning meetings at CHCH, GRSM, CAHA.
Data analysis	5%	Work completed on 2017 Annual Report.
Data management	10%	Routine data management tasks. Fire records. GIS data.
Supervision/Admin	15%	Supervision, Performance evaluations, Training, IDPs, travel, payroll, crew support, purchasing etc.
Fire Operations	10%	Prescribed burns at GRSM, KIMO, and HOBE. 2-week assignment as IC5/FFT1 on Ferguson Wildfire in CA.
Writing	5%	Work on publications. Proposal writing. Annual report. Detailed correspondence.
Educational Outreach	10%	Presentations to Fire Learning Network, GRSM Resource Education staff, Smokies Native Plant Society, Purdue University Field Trip, GRSM VIP Field Trip, CUGA Resource Education Staff. Landscape Conservation Forecasting Webinar. Interviews with Smoky Mt. News and WBIR
Partnerships	5%	Continued communications with numerous partners. TNC, FLN, CAFMS. Coordinated Fire Ecology/Fire Effects Training and Workshop at GRSM for SER and NER NPS ecology staff.
Research/ Publications	5%	Contributed to proposals, reviewed proposals, met with multiple researchers to share information
Miscellaneous	3%	Mostly communication; E-mails, phone calls, informal planning discussions.
Training	2%	Supervisory and required NPS training; fire refresher; READ Training

Table 2. Fire Effects Crew 2018 Accomplishments/Focus Areas

Category	Percent Time	Notes
Planning	10%	Planning related to prescribed fire projects including meetings, preparation for burns and communications of objectives
FMH plots	10%	FMH plots at CONG, GRSM, KIMO and BISO, CAHA
Qualitative Monitoring	5%	Completed Qualitative monitoring at BISO, KIMO, GRSM
CBI plots/Landscape Fire Effects Monitoring (LFEM)	20%	Long term LFEM plots at GRSM CT2 WF(permanent plots)
Wildfire assignments	5%	Lead –HECM-Ferguson Arulanantham- Type 2 crew Ferguson Fire
Prescribed fire projects	15%	Assisted with implementation and mop-up of burns at CONG, GRSM, KIMO, MOCR AND HOBE
Non-fire fuels projects	< 5%	Photo document Ski Mountain Fuels Reduction Project (1 mile section)
Data entry	10%	99% entered with thanks to crewmember Allyson Arulanantham
Data analysis	<5%	This is expected to be very low number or zero for fire effects crew/lead monitor
Supervision/Admin	20%	Supervision of crew for completing field and office work, as well as time, travel credit card and purchasing paperwork. Other Administrative duties accomplished were submitting CY2017 fire polygons to Regional Fire GIS coordinator. Quality Checking AP Zone Fire Occurrence Data
Training	<5%	LEAD served as coordinator for and Crewmember attended national READ training in Pigeon Forge during November. LEAD attended Grass workshop at Highlands Biological Institute. Lead and Crewmember attended FLN workshop. LEAD attended Engine Academy instituted by Florida State parks
Miscellaneous	<1	

The End.