National Park Service
U.S. Department of the Interior

Fire and Aviation Management

Southern Appalachian/Piedmont Fire Effects Monitoring Annual Report, 2017

"Grass-stage" longleaf pine seedling at Congaree National Park. The restoration of this species' regeneration is a major success for the National Park Service.

On the Cover:

NPS Fire Planners, Ecologists, and Fire Effects Monitors from the Northeast and Southeast Regions came together to train and collect burn severity data from the Chimney Tops 2 wildfire during August of 2017. Pictured (from left) are: Allyson Arulanantham (Appalachian Zone), Andy Ruth (NERO), Carol Fields (MS River Zone), Missy Forder (SERO), Rob Klein (App Zone), Cynthia Worthington (MS River Zone), Bob Boensch (MS River Zone), and Matt Wood (App Zone). Wylie Paxton not pictured.

Southern Appalachian/Piedmont Fire Effects Monitoring Annual Report, 2017

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Introduction

As expected, the 2017 fire ecology and fire-effects monitoring workload was dominated by the response to the 2016 wildfire season in Great Smoky Mountains NP. Through the spring and summer of 2017, the team installed 29 permanent plots and completed 39 Composite Burn Index (CBI) plots in order to create a burn severity map and to enable long-term fire-effects monitoring of the Chimney Tops 2 wildfire (**Table 1**). This was the first year of a 2-year plot establishment effort, and the preliminary results from this work were presented on a poster at the International Fire Ecology Congress in Orlando. The results were also shared in an oral presentation to GRSM staff and partners, and they are included in the GRSM section of this annual report.

Long-term monitoring of prescribed burns and mechanical fuel treatments was completed at GRSM, Congaree NP (CONG), Big South Fork NRRA (BISO), Kings Mountain NHP (KIMO), Cumberland Gap NHP (CUGA), and Cumberland Island NS (assisting the MS River Zone) (**Table 1**). Highlights from this year's monitoring include the initial results of the Harry Hampton VC mechanical fuels treatment project at CONG. Data and photos from this project represent the program's most complete dataset from a mechanical fuel reduction project, and the results can be found in the CONG section of this report. Additional work completed at BISO includes severity mapping and monitoring of the 2016 Chimney Rock wildfire, and results of this work are featured in the BISO section of this annual report. Notably, almost all of the 2017 field data were collected on tablet computers, representing a major step forward in a major transition for the program.

The third entry of fire into the North-Central burn unit at KIMO was a highly successful growing-season burn. Note the hundred and thousand-hour fuels that have resulted from small trees being top-killed during previous burns.

The wildfire workload during 2017 was a fraction of that during the historic 2016 season, but the ecology and monitoring team did respond to a wildfire at Chattahoochee River NRA and two GRSM wildfires during an exceptional wind event on May 4, 2017 – providing fire suppression and fire mapping support. Wylie Paxton supported wildfire responses at Big Cypress NP and during the busy fire season in Montana.

The team also supported prescribed burning at GRSM, CONG, BISO, and KIMO (**Table 2**). This year's burns featured interesting third-entry burns of oak and shortleaf-pine woodlands at BISO and KIMO. Each of this year's projects and some of the initial monitoring are featured in the respective sections of this report.

Table 1. Appalachian/Piedmont Fire Effects Monitoring Program: 2017 Plot Workload and Total Plots Installed

Park	Monitoring Unit	Plot Type	Pre-burn 2017	Immed. Post 2017	Postburn (1-20 yrs) 2017	Annual Total 2017	Total Plots
Big South Fork (BISO)	Little Bluestem	FMH Forest Plot				0	4
	Shortleaf Pine	FMH Forest Plot			1	1	2
	White Oak	FMH Forest Plot			1	1	13
	LFEM	Modified FIREMON Species Composition			9	9	26
	CBI	CBI				0	9
	Fuels Transect	Fuels Transect				0	4
Blue Ridge Parkway (BLRI)	Chestnut Oak	FMH Forest Plot				0	2
	LFEM	Modified FIREMON Species Composition				0	7
	Fuels Transects	Fuel Transect				0	6
	Photo Points	Photo Point				0	2
Cape Hatteras (CAHA)	LFEM	Modified FIREMON Species Composition				0	15
	Photo Points	Photo Point				0	33
Congaree (CONG)	Loblolly Pine	FMH Forest Plot				0	5
	Longleaf Pine	FMH Forest Plot				0	5
	Harry Hampton Mastication (LFEM)	Modified FIREMON Species Composition			7	7	17
Cowpens (COWP)	Southern Red Oak	FMH Forest Plot				0	2
Cumberland Gap (CUGA)	Scarlet Oak	FMH Forest Plot			4	4	16
	LFEM	Modified FIREMON Species Composition				0	10
Great Smoky Mountains (GRSM)	Black Oak	FMH Forest Plot					8
	Scarlet Oak	FMH Forest Plot			1	1	16
	Yellow Pine	FMH Forest Plot			1	1	40
	LFEM	Modified FIREMON Species Composition			29	29	65
	CBI				39	39	109
	Fuels Transect	Fuels Transect				0	7
Kings Mountain (KIMO)	Blackjack Oak	FMH Forest Plot		2	2	4	8
	Chestnut Oak	FMH Forest Plot				0	21
	LFEM	Modified FIREMON Species Composition			2	2	20
	Fuels Transect	Fuels Transect				0	3
Moores Creek (MOCR)	Photo Points	Photo Point				0	2
Total			**0**	**2**	**96**	**98**	**477**

Table 2. Summary of 2017 Fuels Treatments and Monitoring

Park	Burn Unit/Treatment Area	Plots?	Other Monitoring	Acres
Big South Fork NRRA (BISO)	Divide Road North Rx	No	Yes (Qualitative, LFEM and FEMO)	378
	Joe's Branch Rx	No	No	20
Cape Hatteras NS (CAHA)	Bodie Island Mechanical	No	No	90
	Ocracoke Mechanical	No	No	12
Congaree NP (CONG)	Red Bluff Rx	No	Yes (FEMO, Qualitative)	229
	VC Mastication	Yes	Yes	20
Great Smoky Mountains NP (GRSM)	Increase Fields Rx	No	Yes (FEMO)	320
	Tipton-Oliver Fields Rx	No	Yes (FEMO)	111
	Upper Tater Field Rx	No	Yes (FEMO)	31
	Old Field Rx	No	Yes (FEMO)	85
Kings Mountain NMP (KIMO)	North-Central Rx	Yes (FMH Plots)	Yes (FEMO, LFEM)	400
	West-End & Long Branch Mechanical	No	No	40
Moore's Creek NMP (MOCR)	Savanna & North-East	No	No	30
Total	**13**	**2**	**8**	**1766**

Table 3. Fire Ecology/Fire Effects Staffing 2017

Ecologist and Monitors	Starting Date	Ending Date	# of Pay Periods	READ Qualified (Yes or No)	Training and Development
Rob Klein (Fire Ecologist)	1/1/17	12/31/17	26	Yes	**24 *interviews, field trips, and fire education presentations*. Participated in FEMA Soil Stabilization working group during the early months of 2017. Strong involvement in local/regional research. Poster presentation at AFE. Co-author on 2 publications. Co-author of GRSM Landscape Conservation Forecasting project report. WIMS/ FireFamily Plus training. Coordinated SER/NER joint monitoring/training workshop. Participated in Starfire for APP Zone.**
Wylie Paxton (Lead Monitor)	1/1/17	12/31/17	26	Yes	**S-236 training. Grass ID Workshop. Faller 3 refresher. READ for Cobbly Nob WF Rehab. READ on Cowbell WF (BICY). HECM on Lodgepole Complex, MT. Presented CT2 Severity/Effects to NC Rare Plants meeting. Oral Presentation at AFE. Completed mapping for 2016/2017 Zone wildfires and fuels projects.**
Matt Wood (Assistant Lead)	1/1/17	12/31/17	26	No	**Major work on producing burn severity maps and working with USGS to correct their map products. Map of CT2 WF severity was featured in AFE Poster. Led efforts in transition to tablet data collection. Created maps for numerous Community Wildfire Protection Plans in Sevier and Blount Counties, TN. Helped lead Chimney Tops 2 field trip**
Allyson Arulanantham (STF Crewmember)	3/19/18				**EOD March 18, 2018 *Congratulations Allyson!***
Allyson Arulanantham (Seasonal Crewmember)	6/12/17	11/11/17	11	No	**Full season of on-the-job training: RX burning operations, FMH, CBI, FFI, LFEM, tablet data collection. Led T&E bat habitat survey. Presented results from 2017 field season to GRSM staff/partners. S-290.**

There was an incredibly strong demand for fire information and education throughout 2017 at GRSM, and the fire ecology/fire effects team played a central role in responding to this demand. Numerous oral presentations, field trips, and media interviews were provided to Park staff, NPS partners, and the public. The focus of these interactions was education about the fire ecology and fire history of the area, sharing information about the effects of the Chimney Tops 2 wildfire, and providing forecasts about the future of the burned forests within the National Park. The fire ecology staff also played a key role in collaborating and sharing information with the academic research community. Aside from fostering several research proposals and projects to study the effects of the 2016 southern Appalachian wildfires, long-term fire effects data from multiple Parks within the Appalachian-Piedmont monitoring network were used in several new regional analyses. In particular, through a collaboration with the US Forest Service Southern Research Station, fire effects data from 3 NPS Regions and 13 separate NPS units (including BISO, CUGA, GRSM, KIMO, and CONG) were featured in two publications (*see below*) that seek to improve the understanding and modeling of postfire mortality for eastern tree species. It is worth noting that the existence of a long-term fire effects monitoring program provides the National Park Service with a unique ability to tell these stories and facilitate critical research.

Rob Klein led a field trip for the Tennessee Chapter of The Nature Conservancy to survey the effects of the Chimney Tops 2 Wildfire in GRSM. The Fire Ecology and Effects team played an important role in interpreting this wildfire event for Park Staff and the public.

Remaining highlights from 2017 included another highly successful Southeast Region/Northeast Region collaborative workshop at Great Smoky Mountains. In August, the Appalachian-Piedmont crew hosted fire planners, fire ecologists, and fire-effects monitors from the NER Office, SER Office, and the Mississippi River FMZ for a week of field training, data collection, and a workshop on program development. The group welcomed Bob Boensch as the new Mississippi River Zone Fire Ecologist and Andy Ruth as the new NER Fire Planner/Ecologist. The event resulted in a stronger network for NPS fire ecology in the eastern U.S., and will help to create a more coherent vision for the larger NPS program. The model of collaborative fieldwork has also enhanced the operational capacity of fire-effects monitoring in both the Northeast and Southeast Regions. In 2017, these efforts resulted in increased data collection at GRSM, and later in the season, when the Appalachian-Piedmont crew traveled to Cumberland Island to assist the Mississippi River crew in time-critical data collection.

Program staffing continued to be a significant strength of the fire effects monitoring program (**Table 3**). Aside from the substantial monitoring and data management accomplishments as a crew, each individual had a long list of service and accomplishment that represent the ongoing

achievement of many of the goals of our local, regional, and national Fire Management program. Most importantly, we welcomed Allyson Arulanantham as our new permanent crew-member on the Appalachian-Piedmont Fire Effects Monitoring team. Allyson worked as a seasonal crew member for the program during 2017, and accepted the permanent position in November. Allyson brings great skills, knowledge, and enthusiasm to our program. She starts in her new position in March 2018.

2017 Publications

Keyser, T.L, V.L. McDaniel, R.N. Klein, D.G. Drees, J. A. Burton, and M.M. Forder. 2017. Validation and development of postfire mortality for upland forest tree species in the southeastern United States. In Keyser and Keyser, eds. 2017. Proceedings of the 2017 Forest Vegetation Simulator e-Conference. e-Gen. Tech. Rep. SRS-224.

Keyser, T.L, V.L. McDaniel, R.N. Klein, D.G. Drees, J. A. Burton, and M.M. Forder. 2017. Short-term stem mortality of 10 deciduous broadleaved species following prescribed burning in upland forest of the southern US. International Journal of Wildland Fire: https://doi.org/10.1071/WFI7058

Big South Fork National River and Recreation Area (BISO): 2017 Fire Effects Monitoring Annual Report

Activity Summary

During 2017, the Appalachian-Piedmont 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 2017. In March, Wylie Paxton participated in the Divide Road North prescribed burn; the burn and initial monitoring work are described in the "*Review of 2015 Projects*" below.

The entire crew and fire ecologist returned in mid-July for a full week of monitoring. Monitoring completed during this visit included: long-term monitoring of vegetation and fuels in the Divide Road South burn unit, a fire-effects assessment of the recently completed Divide Road North prescribed burn, and an extensive burn-severity mapping survey of the 2016 Chimney Rock wildfire. The Chimney Rock burn severity map and a pictorial description of that fire's effects are provided in the "Review" section below.

Review of 2017 Projects

Divide Road North Prescribed Burn:

The Divide Road North prescribed burn was completed on March 23, 2017. This is the third time that the 378-acre unit has been burned since 2005, and the first time it has burned independent of the Divide Road South unit. A combination of southern pine beetle attacks and prior burning had resulted in a mosaic of stand conditions, which included large patches of canopy tree mortality. The goals of the 2017 burn were:

- Conduct a relatively low intensity burn that would reduce hazardous fuels and limit further canopy mortality
- Reduce the density of pole-sized trees and hardwood resprouts
- Improve conditions for regeneration of shortleaf pine, oak, and native herbs.

Weather conditions during the burn were mild and well within prescription, with mostly cloudy conditions for most of the day. Observed fire behavior was generally low intensity with flame lengths less than one foot and rates of spread less than 5 chains per hour (**Figure 1**). Some areas with higher fuel loading and more exposure burned slightly hotter, with flame lengths between 3-6 feet. Immediate observations suggested that the burn was successful at achieving the desired goals.

Figure 1. Low intensity backing fires were typical for much of the burn.

Since no permanent plots are located in Divide Road North, monitoring was accomplished through a combination of remote sensing and rapid qualitative assessments. Differenced normalized burn ratio (dNBR) remote sensing was completed by USGS to illustrate both *initial* (within 1 month) and *extended* (first growing season) burn severity. The *initial* dNBR (not pictured) provides evidence of a low severity burn with nearly complete coverage across the landscape – which is a desired result in keeping with the long term goals for BISO uplands.

Extended dNBR (**Figure 2**) provides a clearer picture of the effects of the fire on the dominant vegetation cover, which varies from closed deciduous forest to dense thickets of young hardwood resprouts. Lightly vegetated areas of bare rock and shallow soil (glades) also exist within the unit, particularly at its northern end.

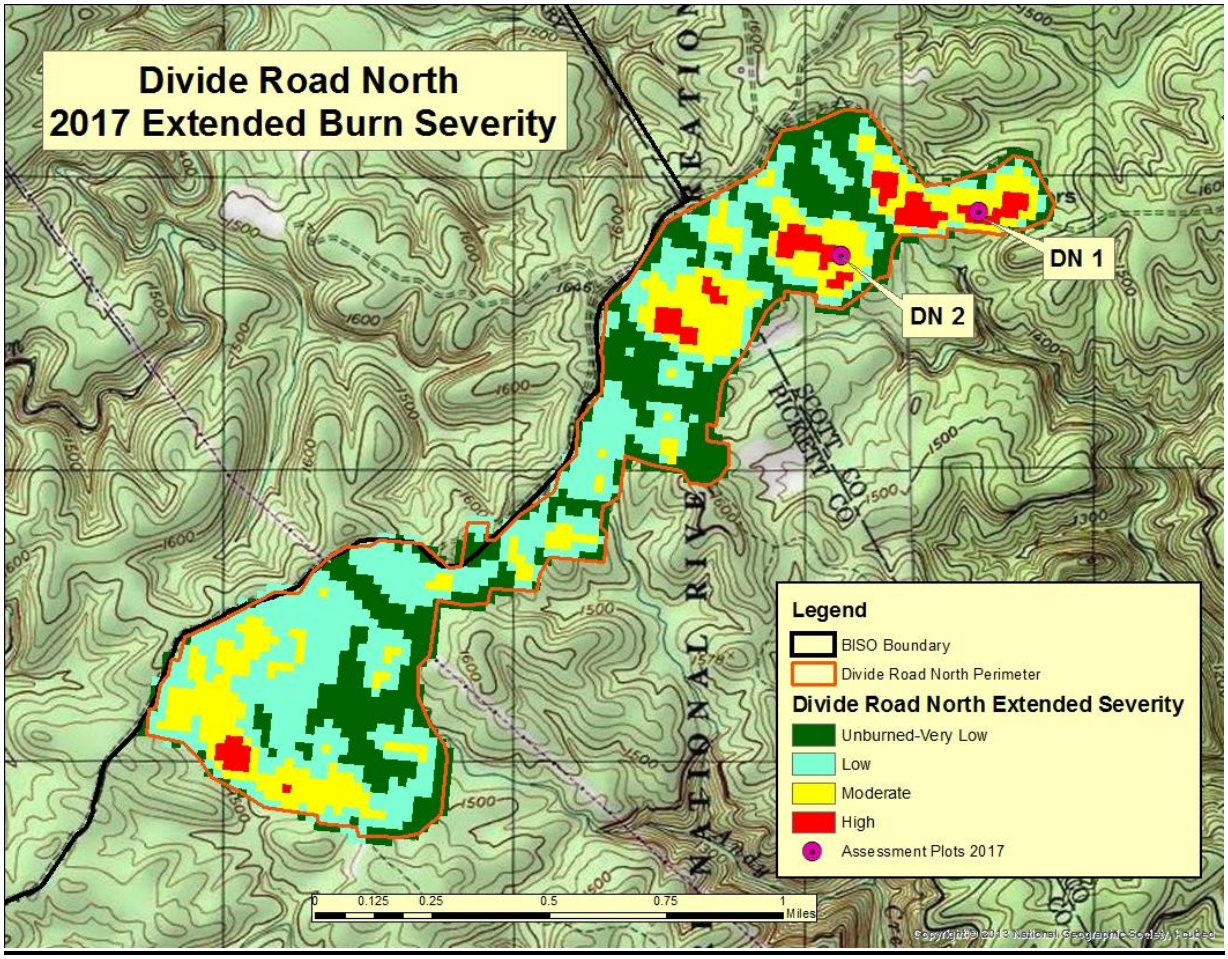


Figure 2. Extended dNBR for Divide Road North 2017. Assessment plots are labeled DN1 and DN2.

Years of experience and compiled data from ground-truthing these extended dNBR maps tells us the following:

- "Unburned/Very Low severity" areas (dark green) experienced very low intensity fire and the dominant canopy and midstory are largely intact. Effects limited to herb layer
- "Low severity" patches (aqua blue) experienced slightly higher intensity fire, resulting in variable effects that include little to no canopy mortality but moderate to high top-kill of midstory and understory trees and shrubs
- "Moderate severity" patches (yellow) are areas with significant canopy mortality (20-60%) and near complete top-kill of understory trees and shrubs. In previously burned sites such as DR North, much of the canopy mortality was a result of prior burning, and the "moderate severity" of the most recent burn indicates that: 1) some overstory cover still exists on the site, and 2) there has been heavy top-kill among the thick woody resprouts that have established in these canopy gaps
- "High severity" (red) areas have high levels (>60%, but often >90%) of canopy mortality. As with moderate severity, this canopy mortality has typically resulted from prior burning, and "high severity" of this most recent burn simply indicates that the young woody sprouts and herbs in these gaps have received a nearly complete top-kill. Small-scale occurrences of glades and dry bluffs that burn can also show up as "high" severity.

Figure 3. Assessment plot DN1. This photo highlights the changes in structure and composition in a high severity site.

Figure 4. Assessment plot DN2. This photo highlights the sparse canopy typical of moderate (almost high) severity sites. The remaining canopy here is dominated by shortleaf pine.

Conclusions:
As with every NPS prescribed-fire restoration site in the southern Appalachians, woodland restoration at BISO remains a work in progress. However, remote sensing coupled with on-the-ground assessments completed during July 2017 suggests that the process at Divide Road is moving vegetation toward the desired condition. Specifically, monitoring (**Figures 2-4, Table 1**) indicates that repeated burning of DR North (3 burns in 12 years) has been effective at:

- greatly increasing the heterogeneity of vegetation structure,
- increasing regeneration of shortleaf pine and various oak species, and
- increasing the cover and fine-scale plant diversity within the site.

These conclusions are also supported by more quantitative long-term monitoring data from two plots in DR South, which has similar vegetation and has received nearly identical prescribed burning treatment over the last 12 years (**Table 2**).

Table 1. Rapid assessment plots – Divide Road North, 2017.

	DN 1	DN 2
Veg Type	SBR Escarpment shortleaf pine-oak	App shortleaf pine-mesic oak forest
Severity Class	High	Moderate
% Overstory cover	0	30%
Overstory species	n/a	shortleaf pine, chestnut oak, tulip poplar
% Intermediate tree cover	0	0
Intermediate species	n/a	n/a
% Tall shrub/sapling cover	10-20%	50-60%
Tall shrub/sapling species	red maple, sourwood, chestnut oak, shortleaf pine	sassafras, sourwood, red maple, shortleaf pine
% Herb layer cover	60-75%	50-60%
Herb layer species	winged sumac, mt. laurel, silkgrass, anise-scented goldenrod, black needle grass	sassafras, sourwood, red maple, black needle grass, anise-scented goldenrod, low bush blueberry
Comment	Tallest species in sapling stratum is PINECH; herbs abundant with abundant flowering	Tallest species in sapling stratum is PINECH; herbs widespread but not abundant

Table 2. Long-term fire effects – Divide Road South (n=2 plots)

	Preburn (2005)	Year 2 following 3rd burn (2017)
Canopy tree (>15cm) density	310/ha	175/ha
Pole tree (<15cm) density	1320/ha	320/ha
Herb cover	22%*	44%
# of herb species/transect	4*	10
Oak seedling cover	4%*	26%

* These data were collected the first growing season after the first burn (August, 2005)

Chimney Rock Wildfire

The Chimney Rock wildfire occurred from November 18-29 of the busy 2016 southern Appalachian fall fire season. This was the largest wildfire (534 acres) at BISO since the Schoolhouse and Darrow Ridge wildfires of 2001. Monitoring efforts were undertaken in 2017 with the following goals:

1) create a burn severity map of the wildfire
2) survey the effects of the fire on vegetation structure and composition
3) scout for invasive plant species that are commonly found in high-severity wildfires.

The fire effects team worked with partners at USGS to create a differenced-Normalized Burn Ratio (dNBR) map of extended burn severity for the Chimney Rock Wildfire (**Fig. 5**). During the July 2017 monitoring visit to BISO, the ecologist and crew traversed several ridges and slopes within the fire perimeter to conduct qualitative assessments and photo-document some of the effects of the wildfire (**Fig. 6-10**). These photos correspond to waypoints labeled on the map, and provide examples of burn severity classes depicted in the dNBR map.

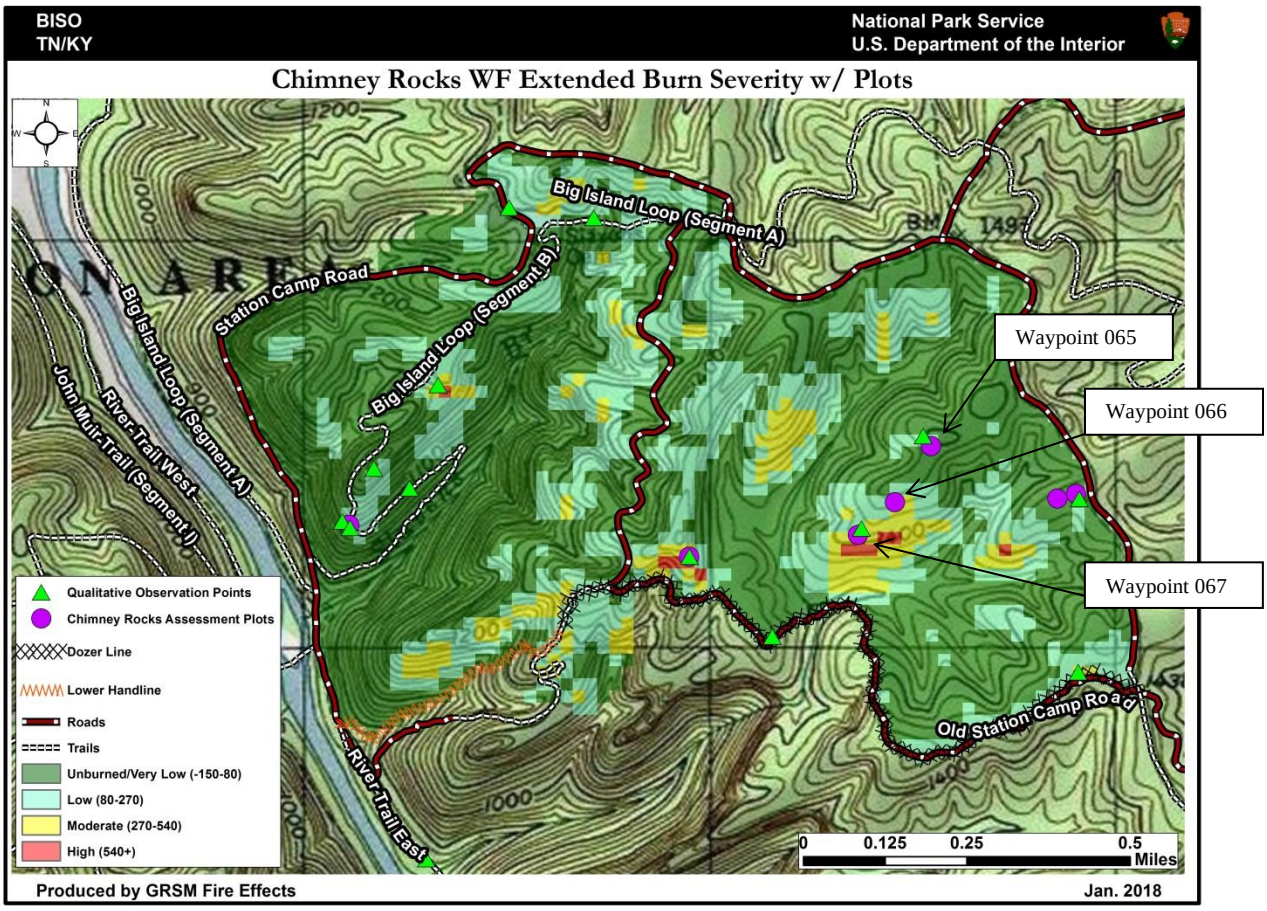


Figure 5. Extended dNBR severity map for Chimney Rock wildfire.

Figure 6. Wylie Paxton mapping and recording qualitative fire effects assessments of the Chimney Rock wildfire.

Figure 7. Waypoint 065 – "Very Low" burn severity in dry mixed oak forest. This severity class accounts for a large majority of acres within the burn footprint.

Figure 8. Waypoint 066 – "Low-Moderate" severity in dry mixed oak forest.

Figure 9. Waypoint 067 – "High" burn severity in xeric ridgetop oak forest.

Figure 10. Yellow pine seedlings (possibly shortleaf pine) were observed in high burn severity sites. Seedlings of the exotic invasive species *Paulownia tomentosa* (princess tree) were also observed in at least one "high" severity area along the Big Island Loop Trail.

Long Term Monitoring Results

Monitoring results for most of the management-objective variables have been re-analyzed for the 2017 report (**Table 3**). In all cases, there are either insufficient plot numbers and/or the plots have not burned the required number of times. As a result, we cannot make any inferences with even 80% confidence; however, trends in the data (and results from individual burn monitoring such as Divide Road) provide a strong indication that prescribed burning has been quite effective at moving oak and pine forests towards the desired conditions.

The objective for oak seedling density in the "Dry Oak Forest" monitoring type needs to be re-evaluated for inclusion of shortleaf pine seedlings as a desired result. It is likely that a subset of the original "oak" plots should be managed for shortleaf pine regeneration instead of solely for oak regeneration. This is not the case for all plots identified as "oak" plots, but rather for those that have or had shortleaf pine as a codominant in the existing canopy. This analysis is currently underway, and may have implications for other long-term objectives and burning techniques.

Additional long-term monitoring results are provided for key variables in the "dry oak forest" forest type (**Figures 11-14**). These graphs may offer a clearer way to visualize the trends and variability in fire effects from the 12-year old prescribed burning program. Sample sizes for the graphs match those provided for the same variables in **Table 3**.

Table 3. 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 -*** *11 have burned once* *5 have burned twice* *3 have burned three times* *3 remain unburned*	>50% Reduction in total fuel loading	**Total fuel reduction** After one burn (n=10): 52% (±3%) After 2 burns (n=8): 43% (±7%) After 3 burns (n=3): 46% (±27%)	**Insufficient data, but the trend is very positive**	**2018**
	>70% Reduction in pole-sized tree density (≤ 15cm dbh)	**Pole reduction** After one burn (n=10): 62% (±11%) After 2 burns (n=4): 93% (±10%) After 3 burns (n=2): 69% (±27%)	**Insufficient data, but the trend is very positive**	**2018**
	20-40% Reduction in overstory tree density(>15cm dbh)	**Overstory reduction** After one burn (n=11): 5% (±3%) After 2 burns (n=5): 36% (±17%) After 3 burns (n=3): 28% (±40%)	**Insufficient data, but the trend is very positive**	**2018**
	>200 tall (>1m) Oak seedlings /ac	**Oak Seedlings:** 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) ***3 plots-*** *3 have burned four times* *1 has burned three times*	>70% Reduction in pole-sized tree density	**Pole reduction:** After 1 burn *(n=3)* = 14% (±16%) After 2 burns *(n=3)* = 29% (±23%) After 3 burns *(n=3)* = 34% (±23%) After 4 burns *(n=2)* = 35% (±20%)	**Insufficient data, but the trend is very positive.** ***Objective may need to be revised.***	**2018**
	>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 $\alpha = 0.20$

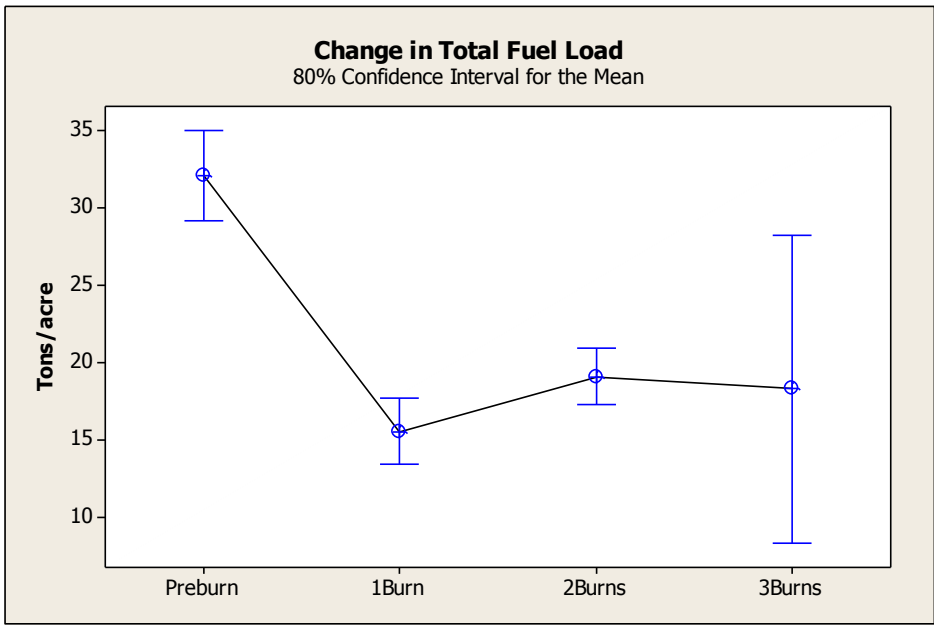


Figure 11. Change in total fuels following three burns. "Dry Oak Forest" monitoring type.

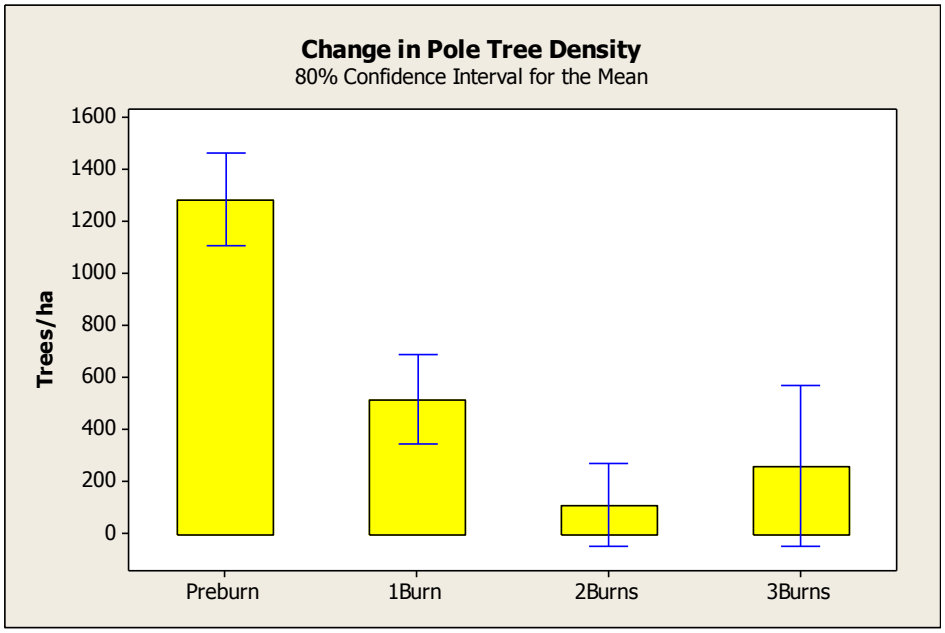


Figure 12. Pole-size tree (<15cm dbh) density following three burns. "Dry Oak Forest" monitoring type.

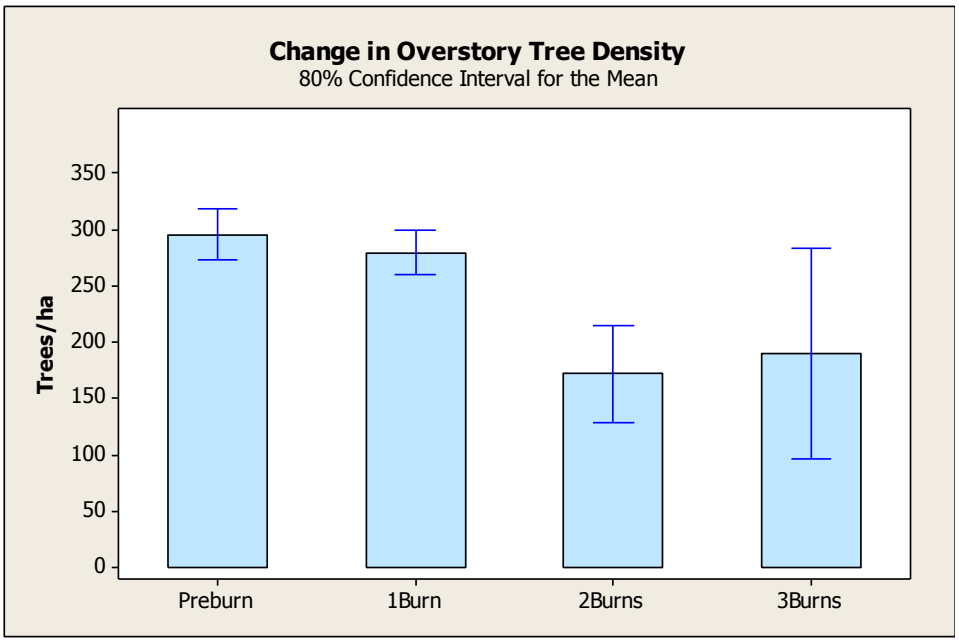


Figure 13. Overstory tree density following three burns. "Dry Oak Forest" monitoring type.

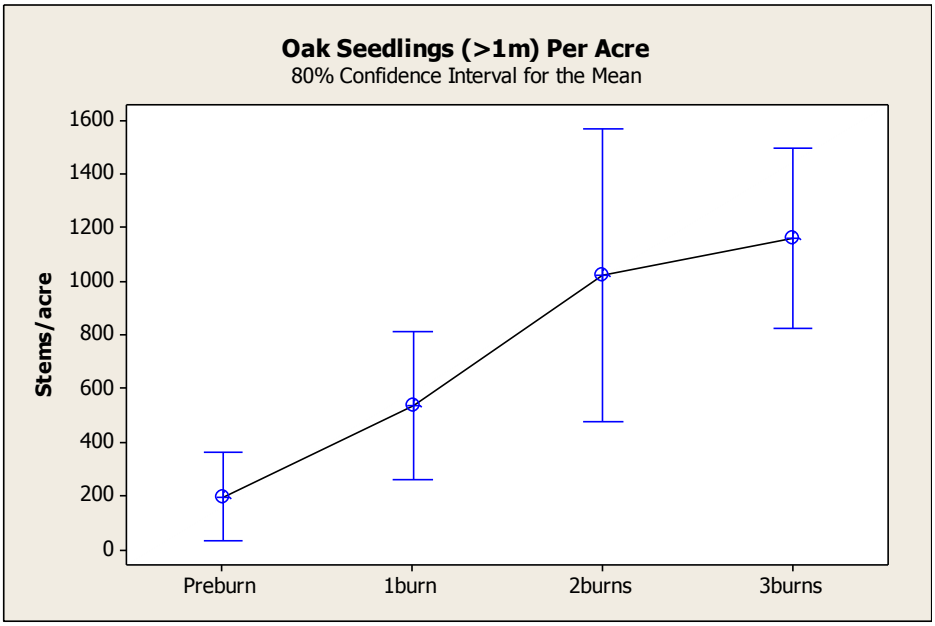


Figure 14. Density of tall Oak seedlings following three burns. "Dry Oak Forest" monitoring type.

Blue Ridge Parkway (BLRI):
2017 Fire Effects Monitoring Annual Report

Activity Summary

No prescribed burns were completed at BLRI during 2017. Consequently, the Appalachian-Piedmont fire effects monitoring team did not complete any field monitoring or site visits to BLRI this year. The fire ecologist contributed data and represented BLRI during early development of the NPS Starfire program for the Appalachian-Piedmont Fire Management Zone. Starfire is a planning tool to prioritize and inform prescribed burning, fuels treatments, and wildfire management in NPS units. Most of our program's support this year centered on creating, validating, and submitting maps of the wildfires that occurred during the busy 2016 fire season (please see last year's report). Providing accurate maps is a critical component of both wildfire documentation and fuels project management, and our efforts support the increased emphasis on fire mapping for all NPS units.

Additional data management work was completed to support monitoring of the 2016 Air Bellows prescribed burn (**Figure 1**), however an analysis of the data could not be completed in time for this report. Plans for the coming year include completion of that analysis and reporting. Field work during the coming year will be contingent on plans to conduct additional prescribed burning or fuels reduction projects.

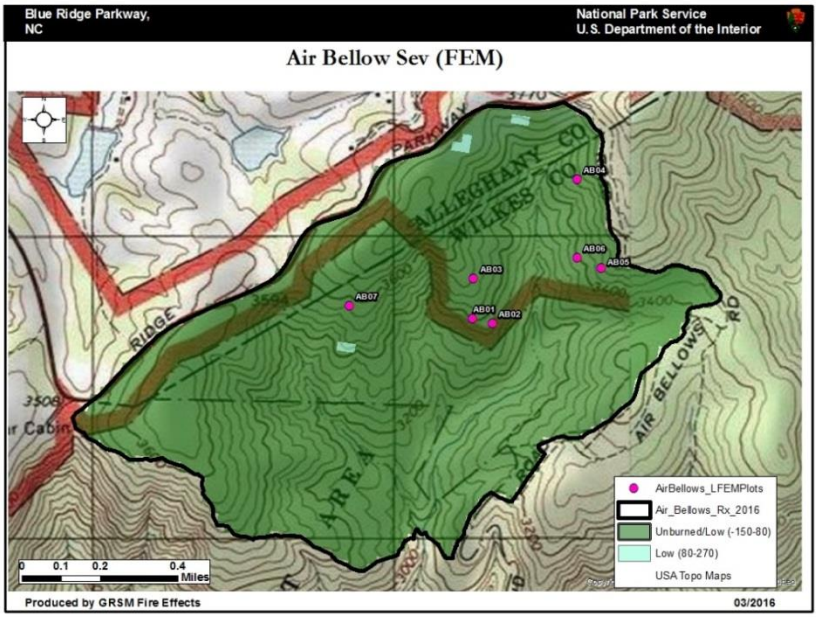


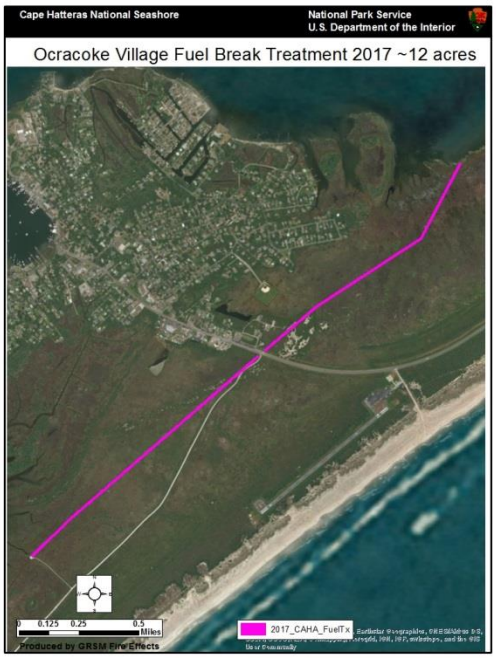
Figure 1. Burn severity mapping (dNBR) of the Air Bellows Prescribed burn, with permanent plot locations. The post burn data have been compiled and an analysis should be completed in the coming months.

Cape Hatteras National Seashore (CAHA): 2017 Fire Effects Monitoring Annual Report

Activity Summary

No prescribed burns were completed at CAHA during 2017. Consequently, the Appalachian-Piedmont fire effects monitoring team did not complete any field monitoring or site visits to CAHA this year. The fire ecologist contributed data and represented the Outer Banks Group during early development of the NPS Starfire program for the Appalachian-Piedmont Fire Management Zone. Starfire is a planning tool to prioritize and inform prescribed burning, fuels treatments, and wildfire management in NPS units. Other program support centered on validating and submitting maps for the 2017 fuel-break treatments on Bodie Island and Ocracoke Village (**Figures 1 and 2**), in addition to creating and submitting maps for several historical wildfires and fuels treatments throughout the Outer Banks. Providing accurate maps is a critical component of both wildfire documentation and fuels project management, and our efforts support the increased emphasis on fire mapping for all NPS units.

Plans for the coming year include a monitoring trip to complete year-5 post-burn monitoring of the Bodie Island 1.3 prescribed burn unit. Please see the 2015 Annual Report for a summary of the years-1 and 2 post-burn monitoring of this unit. Additional goals for this trip will include an assessment of the Bodie Island and Ocracoke fuel breaks, and a reassessment of fire effects on the Little Kinnakeet wildfire.



Chickamauga/Chattanooga National Military Park (CHCH): 2017 Fire Effects Monitoring Annual Report

No prescribed burns or hazard fuel treatments were completed at CHCH during 2017. Consequently, the Appalachian-Piedmont fire effects monitoring team did not complete any field monitoring or site visits to CHCH this year. The fire ecologist contributed data and represented CHCH during early development of the NPS Starfire program for the Appalachian-Piedmont Fire Management Zone. Starfire is a planning tool to prioritize and inform prescribed burning, fuels treatments, and wildfire management in NPS units. Other program support centered on creating, validating, and submitting maps for the busy 2016 wildfire season. Providing accurate maps is a critical component of both wildfire documentation and fuels project management, and our efforts support the increased emphasis on fire mapping for all NPS units.

The fire ecology/fire effects team is committed to full engagement in any future planning for prescribed burns or fuels reduction projects at CHCH, and is prepared to help develop project objectives and a monitoring plan for such work. Plans for the coming year will thus be dependent upon the planning process for FY19 projects.

Congaree National Park (CONG): 2017 Fire Effects Monitoring Annual Report

Activity Summary

The Appalachian-Piedmont fire ecology/fire-effects monitoring team made a combined three trips to Congaree during 2017. The fire effects crew participated in the May 18 prescribed burn of the Red Bluff burn unit, and returned in June to conduct monitoring of the Harry Hampton VC mechanical fuel reduction. The results of the mechanical fuel reduction monitoring are reported in the "*Review of 2017 Projects*" below. The fire ecologist accompanied the crew for the June monitoring trip, and returned in November to attend the Southeast Coast Inventory and Monitoring annual meeting.

Aside from site visits, he fire ecologist contributed data and represented CONG during early development of the NPS Starfire program for the Appalachian-Piedmont Fire Management Zone. Starfire is a national and regional planning tool to prioritize and inform prescribed burning, fuels treatments, and wildfire management in NPS units. Other program support centered on creating, validating, and submitting maps for the 2017 prescribed burn and wildfire, in addition to creating and submitting maps for several historical wildfires and fuels treatments at CONG. Providing accurate maps is a critical component of both wildfire documentation and fuels project management, and our efforts support the increased emphasis on fire mapping for all NPS units.

Plans for the coming year include participation in the planned RCW/Harry Hampton prescribed burns, monitoring of those burns, and continued monitoring of the Harry Hampton mechanical project.

Review of 2017 Projects

Red Bluff Prescribed Burn:

The Red Bluff prescribed burn was completed on May 18, 2017. This is the fifth time that the 229-acre unit has been burned since 2007, and the first time it has burned independent of the Dawson's Cabin unit. The area is dominated by thick forests of successional and planted loblolly pine of varying age classes. Shortleaf and longleaf pine are occasional associates, and hardwood stands (mostly oak) are scattered throughout in low-lying areas. Previous burns have been a mix of low intensity (2007, 2010) and moderate intensity (2012, 2014), with the latter burns effecting significant top-kill of understory sweet-gum and even significant thinning of midstory loblolly pine. The goals of the 2017 burn were:

- Reduce hazardous fuels by conducting a moderate-intensity burn (flame lengths 1-3') over a high percentage of the uplands within the unit
- Top-kill a high percentage (>70%) of the resprouting sweet-gum in the understory
- Improve conditions for regeneration of shortleaf pine, longleaf pine, and native herbs.

Weather conditions during the burn were mild and well within prescription, however the surface fuels still had relatively high moisture content due to significant rainfall (3") over the previous week. This moisture, coupled with the sheltered conditions of full understory greenup, acted to limit fire intensity and fire spread (**Figures 1-2**). This unit does contain two long-term monitoring plots, but the plots did not burn during this event. Monitoring was thus limited to perimeter mapping, an immediate severity assessment, and a brief visual assessment during the June visit. Immediate observations suggested that the burn, though perhaps lower in intensity and coverage than desired, was effective achieving the goal for top-kill of understory sweet-gum in those areas that burned

Figure 1. Fire behavior was generally limited to flame lengths of <1'. In those areas that burned, this produced leaf scorch of understory sweet-gum by 40-100%.

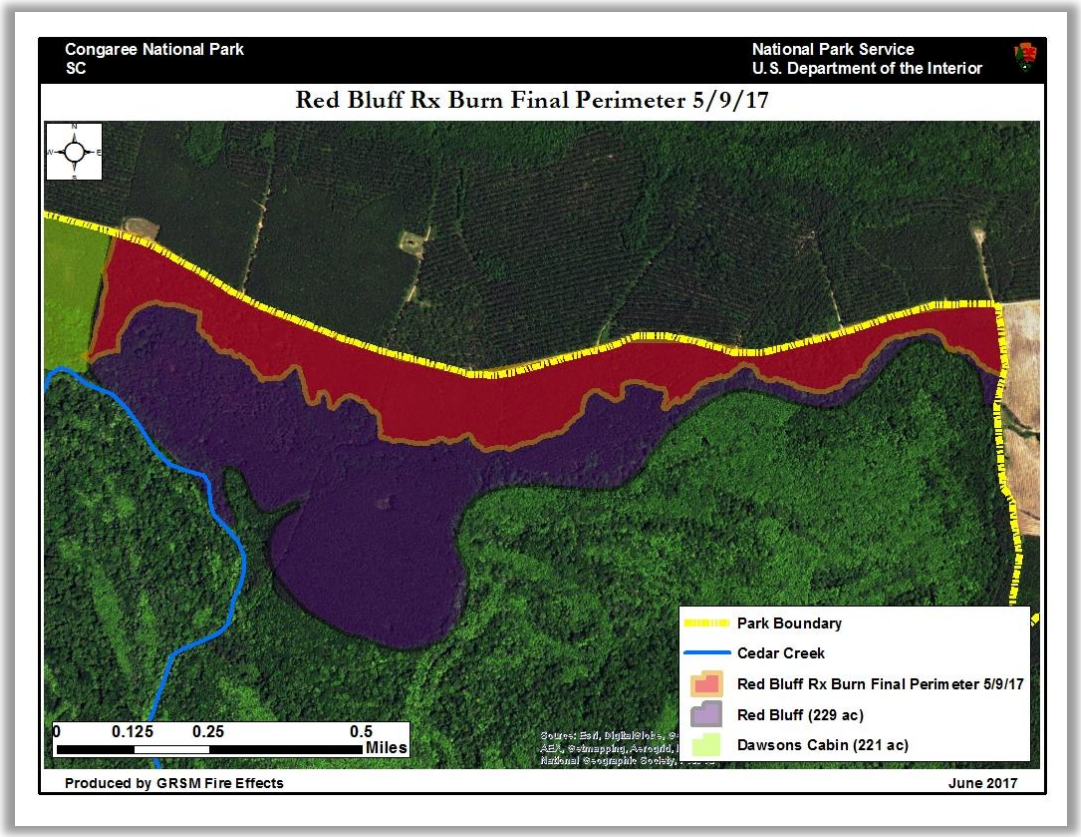


Figure 2. Final perimeter of area burned by the 2017 Red Bluff Rx.

Harry Hampton Mechanical Fuel Reduction:

The Harry Hampton mechanical fuel reduction (mastication) project began in 2016 and continued into 2017. The project was well described in the 2015 and 2016 Annual Reports, and the project objectives were as follows (from PMIS Project Proposal):

- Thin brush and pole-sized trees over 100 acres of upland pine forest
- Immediate 50% reduction in pole–sized tree basal area
- 25% increase in grass/forb cover within 5 years
- Long term goal for tree basal area is 40-70 ft^2/acre
- Conduct monitoring before the treatment and over a 5 year period following treatment.

Monitoring was initiated at the request of CONG Resource Managers in 2015. A total of 17 permanent plots (12 treatment, 5 control) were established; a description of the methods can be found in the 2015 report. Plot locations are shown in Figure 3; only the "Treated Plots" (orange dots) were resampled during summer 2017. The control plots will be resampled in 2018, and the untreated plots will be resampled if/when they are treated.

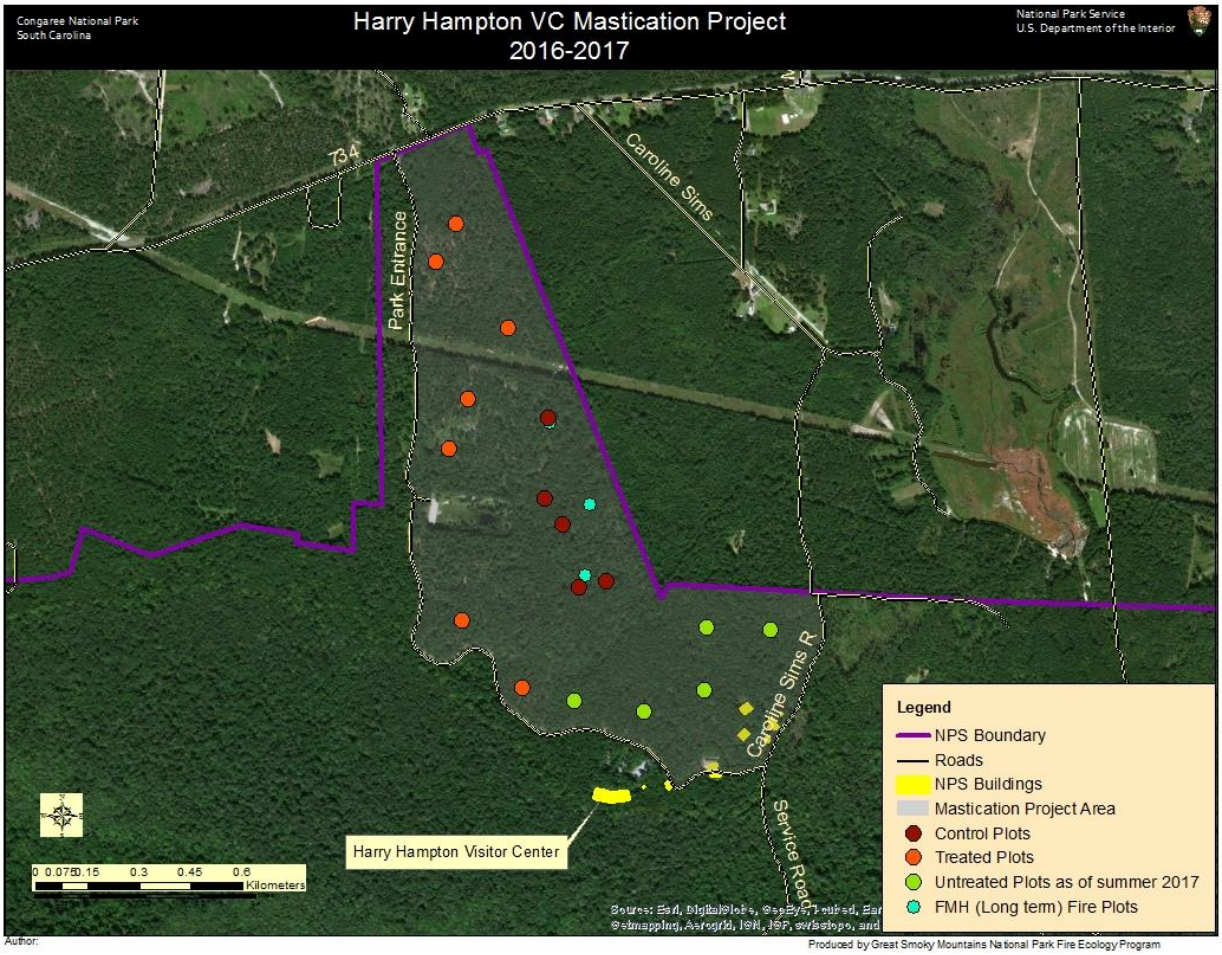


Figure 3. Map of the Harry Hampton project area, with plots. Only the treated plots (orange) were resampled in 2017.

Results

Preliminary results from the first 7 treated plots indicate that the mastication treatments are having a substantial impact on forest structure (**Figures 4-11**, **Table 1**). Strong reductions in pole basal area (-40%) are close to meeting project objectives; however the pretreatment basal area of 23 ft^2/ac indicates that pre-treatment pole basal area was already pretty low in many areas. In fact, four of the seven plots had a pole basal area of "0" during pre-burn monitoring. This low basal area among poles probably reflects the aggressive, repeated burning of the site over the past six years.

Possibly a better measure of the ecological change resulting from the mechanical treatment is the change in cover of the tree canopy (-44%). This increase in light was accompanied by a 16% increase in average herb cover in the plots, which is well on the way towards meeting the longer-term objective. Though sweet-gum was initially reduced by the treatment, it is still abundant in both the sapling layer and herb layer. The additional light may lead to rapid growth of this resprout cohort; however, the planned continuation of prescribed fire should allow control of this growth. Expansion of exotic species such as *Lespedeza cuneata* is also a concern over the long term, though only relatively minor changes were detected by the initial monitoring.

Again, these are only preliminary results from a subset of the plots, and we don't yet have the data from the control plots for comparison. If additional mastication is completed in the remaining plots, the data from all of the plots will allow a more complete analysis.

Figure 4. HH mechanical treatment plot MT05 - pre-treatment.

Figure 5. HH mechanical treatment plot MT05 - 1 -yr post treatment.

Figure 6. Plot MT08 - Pre-Treatment.

Figure 7. Plot MT08 - 1 year post treatment.

Figure 8. Plot MT11 - Photo 0m – Pre Treatment.

Figure 9. Plot MT11 - Photo 0m - 1 year post treatment.

Table 1. Preliminary results of Harry Hampton mechanical reduction plots (n=7).

	Pre-Treatment	1-yr Post Treatment	Avg % Change
Pole Basal Area (ft^2/ac)	23	1.4	-40%
Tree Basal Area (ft^2/ac)	106	91	-11%
Total canopy cover	76%	45%	-44%
Pinus taeda (canopy cover)	45%	30%	-33%
Herb cover	75%	81%	+16%
Sweet-gum cover (sapling size)	26%	16%	-
Lespedeza cuneata cover	1%	3%	-

Long Term Monitoring Results

There has been no update to the long-term monitoring results table for Congaree. The most recent table of results is included below for the reader's reference (**Table 1**). An update to this table should be completed for next year's annual report.

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% *(n=4 plots, 1 burn unit)*	**No**	**2008**
	15-30% Reduction in overstory tree density	Overstory reduction after 5 burns: 4% *(n=4 plots, 1 burn unit)*	**No**	**2008**
	>200 tall (>1m) Longleaf pine seedlings /ac	Preburn density: data not clean After 5 burns: 0 *(n=4 plots, 1 burn unit)*	**No***	**2008**
Loblolly Pine Forest (FPITA1) *5 plots*	>50% Reduction in total fuel loading	Total fuel reduction = 38% Preburn avg.: 33.0 tons/acre After 3 burns: 20.6 tons/acre *(n=3 plots, 1 burn unit)*	**No**	**2008**
	>70% Reduction in pole-sized tree density	Pole reduction: After 1 burn: 38% After 2 burns: 46% After 3 burns: 65% *(n=3 plots, 1 burn unit)*	**No**	**2008**
	25-50% Reduction in overstory tree density	Overstory reduction: After 1 burn: 3% After 2 burns: 3% After 3 burns: 8% *(n=3 plots, 1 burn unit)*	**No**	**2008**

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

Cowpens National Battlefield (COWP): 2017 Fire Effects Monitoring Annual Report

No prescribed burns or hazard fuel treatments were completed at COWP during 2017. Consequently, the Appalachian-Piedmont fire effects monitoring team did not complete any field monitoring or site visits to COWP this year. The fire ecologist contributed data and represented COWP during early development of the NPS Starfire program for the Appalachian-Piedmont Fire Management Zone. Starfire is a planning tool to prioritize and inform prescribed burning, fuels treatments, and wildfire management in NPS units. Other program support centered on creating, validating, and submitting maps from historical prescribed burns, fuel treatments, and wildfires. Providing accurate maps is a critical component of both wildfire documentation and fuels project management, and our efforts support the increased emphasis on fire mapping for all NPS units.

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 FY18 and the planning process for FY19 projects.

Cumberland Gap National Historic Park (CUGA): 2017 Fire Effects Monitoring Annual Report

Activity Summary

During 2017, 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 made one visit to CUGA during 2017. The crew and fire ecologist visited in mid-September for a full week of monitoring. Monitoring completed during this visit included: long-term monitoring of vegetation and fuels in the Harlan Road A burn unit. No prescribed burns were completed in 2017.

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) ***16 plots***	**>50% Reduction in total fuel loading**	**Total Fuel Reduction:** After 1 burn (n=16): 29% (±3) After 2 burns (n=11): 26% (± 2)	**Not yet, but on course**	**2013**
	>70% Reduction in pole-sized tree density (< 15cm dbh)	**Pole Reduction:** After 1 burn (n=16): 39% (±5) After 2 Burns (n=11): 67% (± 3)	**Not yet, but close**	**2013**
	15-30% Reduction in overstory density (>15cm dbh)	**Overstory Tree Reduction:** After 1 burn (n=16): 5% (±5) After 2 Burns (n=11): 8% (±1)	**Not yet, but on course**	**2013**
	>200 tall (>1m) 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% (±1%) After 1 burn (n=14): 4% (±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): 2017 Fire Effects Monitoring Annual Report

Activity Summary

The fire ecology and fire effects team provided numerous services to the host park in 2017. Team members contributed to fire suppression efforts during the May 4 wind/fire event, and participated in prescribed burns in Cades Cove during both the spring and fall burn seasons. Long-term monitoring of prescribed burns was completed at several sites, but the vast majority of the monitoring field work in 2017 centered on monitoring of the 2016 Sevier County wildfires (primarily Chimney Tops 2). Those efforts and preliminary monitoring results can be found below in the "*Review of 2017 Projects*" section of this report. Other major support included providing a large number of fire ecology presentations and field trips to park staff, partners, and the public.

The fire ecologist contributed data and represented GRSM during early development of the NPS Starfire program for the Appalachian-Piedmont Fire Management Zone. Starfire is a planning tool to prioritize and inform prescribed burning, fuels treatments, and wildfire management in NPS units. Other program support centered on creating, validating, and submitting maps from historical prescribed burns, fuel treatments, and wildfires. Providing accurate maps is a critical component of both wildfire documentation and fuels project management, and our efforts support the increased emphasis on fire mapping for all NPS units.

Review of 2017 Projects

Monitoring of 2016 Sevier County Wildfires:

From the poster "***Extended Severity dNBR and Initial Effects of the Chimney Tops 2 Wildfire in Great Smoky Mountains National Park, Tennessee, USA"*** **–** presented at the Orlando Association for Fire Ecology Congress, November 2017.

Introduction

On November 28, 2016, a complex of wildfires burned over 7,000 hectares of public and private land in Sevier County, Tennessee, USA. The largest of these fires, the Chimney Tops 2 Fire (CT2), burned over 4400 hectares of oak, pine, and mixed hardwood forest within the boundaries of Great Smoky Mountains National Park (GRSM). This wildfire burned with locally unprecedented intensity and rapidity, fueled by extreme drought, hurricane-force winds, and flammable vegetation that had not experienced a significant fire in the past 100 years.

The historic nature of the CT2 fire, coupled with its relatively large size and complex vegetation, presents a strong need for greater understanding of its short and long term effects. FIREMON Landscape Assessment and Species Composition methods (1,2) are being used to create basic data products that will support further investigations into both immediate and long-term effects of the CT2 fire. This poster provides preliminary results following the first year of a two-year study. This project advances the development of burn severity mapping techniques for temperate deciduous forests.

Objectives

The objectives of this study are:

1. Create a classified burn severity map for NPS lands within the CT2 wildfire
2. Describe significant features of initial fire effects and vegetation response
3. Illustrate the application of Landscape Assessment methods in the mixed forests of the Southern Appalachian Mountains

Materials & Methods

Multispectral pre-fire and post-fire Operational Land Imager (Landsat 8 - OLI) data were acquired for the burned area from the USGS EarthExplorer website. Cloud free, growing-season images were selected in order to conduct an "extended" severity assessment. Image data are as follows:

Landsat Path/Row: 19/35

Pre-Fire Landsat Scene ID/Date Acquired: Landsat 8 OLI; LC80190352015257LGN01 / 2015-09-14

Post-Fire Landsat Scene ID/Date Acquired: Landsat 8 OLI; LC80190352017246LGN00 / 2017-09-03

Normalized Burn Ratio (NBR) and differenced-Normalized Burn Ratio (dNBR) were calculated following Key and Benson (1).

During this first year of a two-year study, 29 permanent plots ($400m^2$) were established within the CT2 perimeter. For each plot, Composite Burn Index (CBI) ratings were completed following Key and Benson (1), and cover of all plant species within each of 4 forest strata was recorded, following Caratti (2). CBI-only was completed for an additional 10 unburned plots within the fire perimeter.

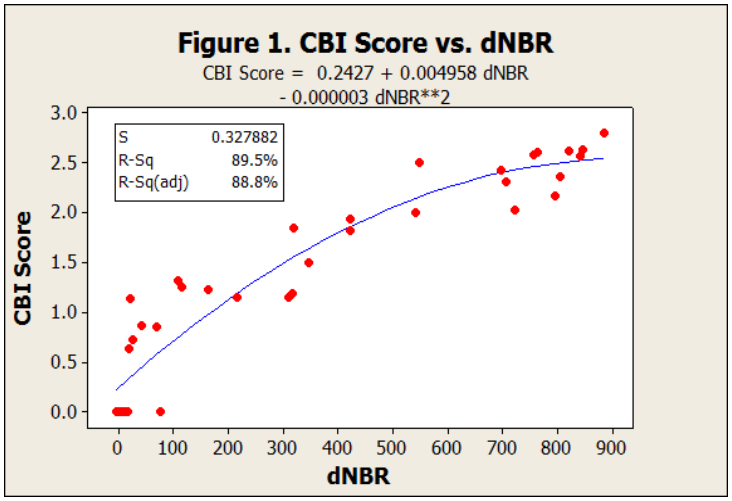
A regression model was developed for CBI plot scores and corresponding dNBR values, and this model was used to help define provisional severity class thresholds for classification of the dNBR image. Descriptive statistics were used to illustrate initial severity and fire effects by severity class for selected variables.

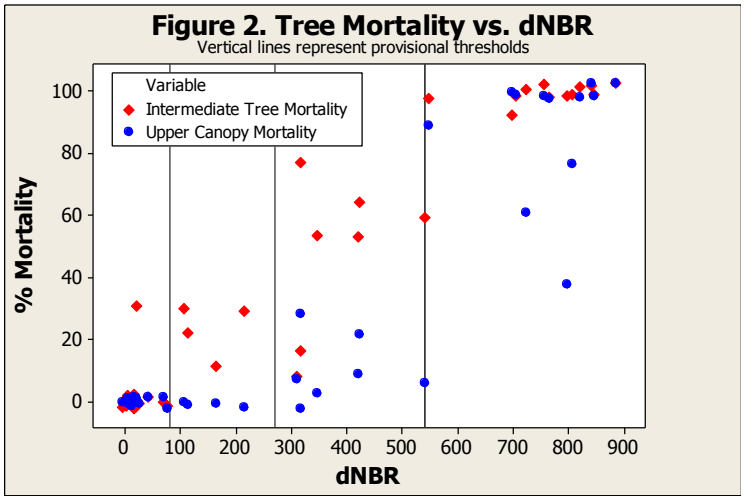
Results

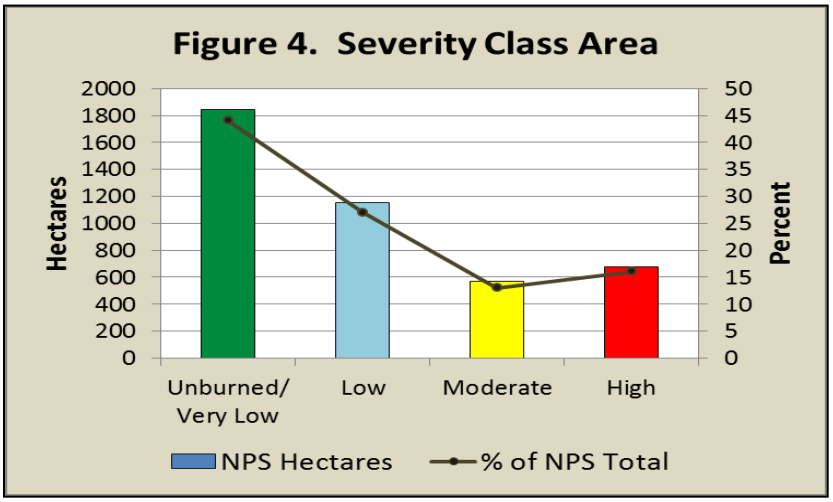
Classified Severity Map

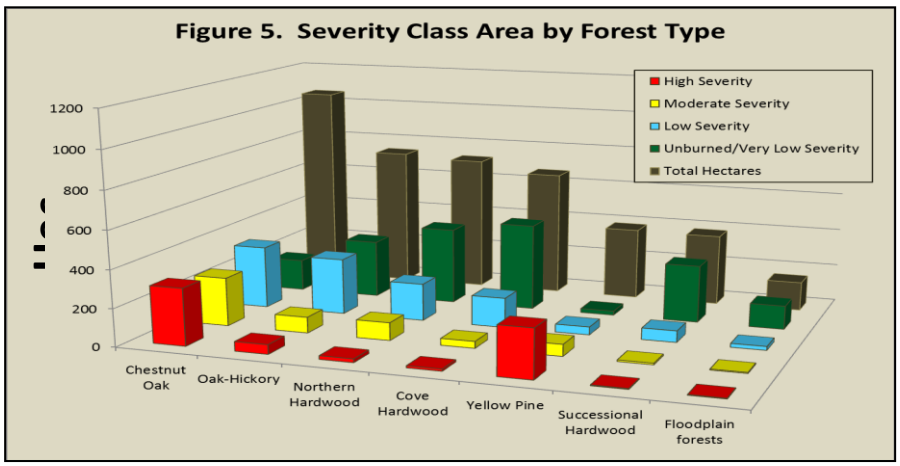
dNBR processing resulted in an unclassified severity image with pixel values ranging continuously from -221 to 1014 within the GRSM lands of the CT2 perimeter. The strong relationship between CBI score and dNBR pixel value ($R^2 = 0.89$, $p<0.001$) indicates that the model has strong predictive power for on-the-ground measures of severity (Fig. 1).

Actual severity classification was guided by the appearance of ecologically meaningful thresholds in the data – principally data for percent mortality of intermediate and upper canopy trees (Fig. 2). These provisional thresholds (dNBR = 80, 270, and 540) were applied to the unclassified dNBR map to produce the draft CT2 burn severity map (Fig. 3). Spatial statistics were calculated to provide the total area of each severity class (Fig. 4) and area of each severity class by dominant forest type within GRSM lands (Fig. 5). Plot photos taken during the first growing season post-fire provide a visual example of the four severity classes.









Fire Effects Description

Mortality of intermediate and upper canopy trees differed among severity classes (Fig. 6), which reflects the role of tree mortality as a key variable in assignment of severity class thresholds. However, tree mortality, and associated change in cover, is a primary factor in long-term vegetation response and fuel accumulation in heavily forested ecosystems, giving tree mortality a central importance in severity class descriptions.

Differences also emerged in effects on the tall shrub/tree sapling layer (data not shown). More notably, survival through escape or resprouting was relatively high (73-84%) regardless of severity class (Fig. 7). The degree of survival through resprouting in high- severity sites was somewhat surprising, and the role that these survivors will play in longer-term vegetation dynamics is unclear.

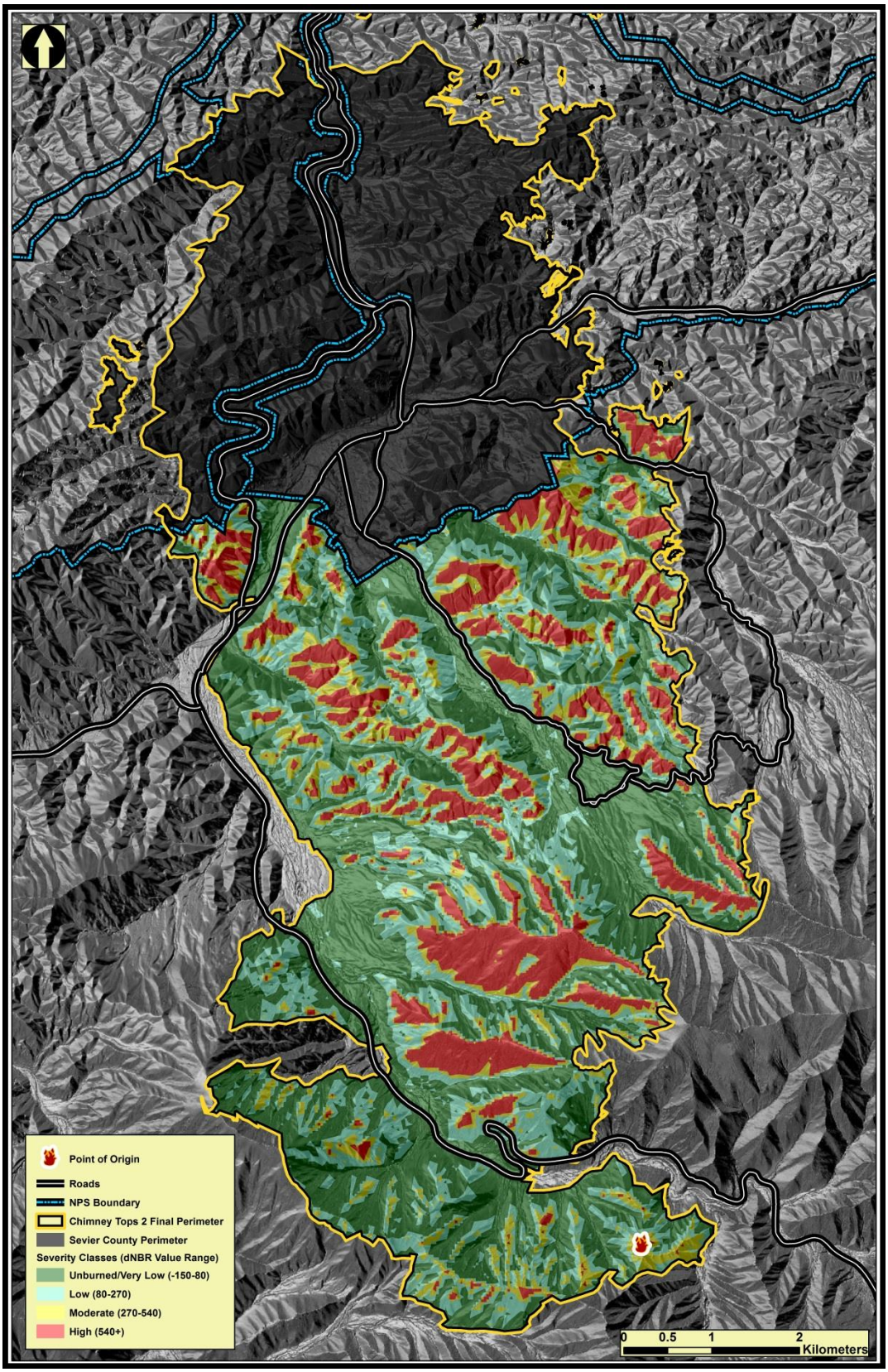


Figure 3. Classified severity of for GRSM lands within the Chimney Tops 2 Wildfire. Photos on the following two pages help to illustrate differences in fire effects.

Unburned/Very Low Severity

First Growing Season Post-Fire

Low Severity

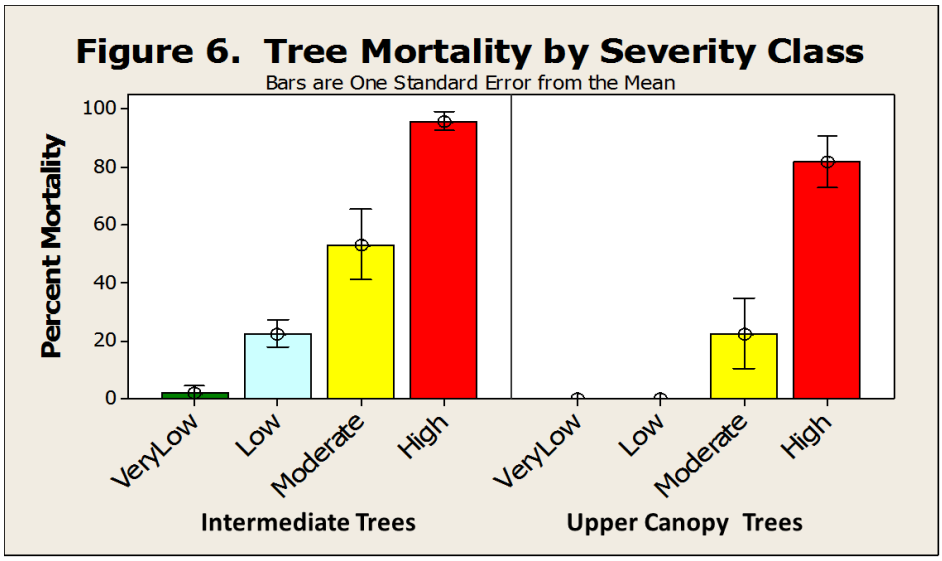
First Growing Season Post-Fire

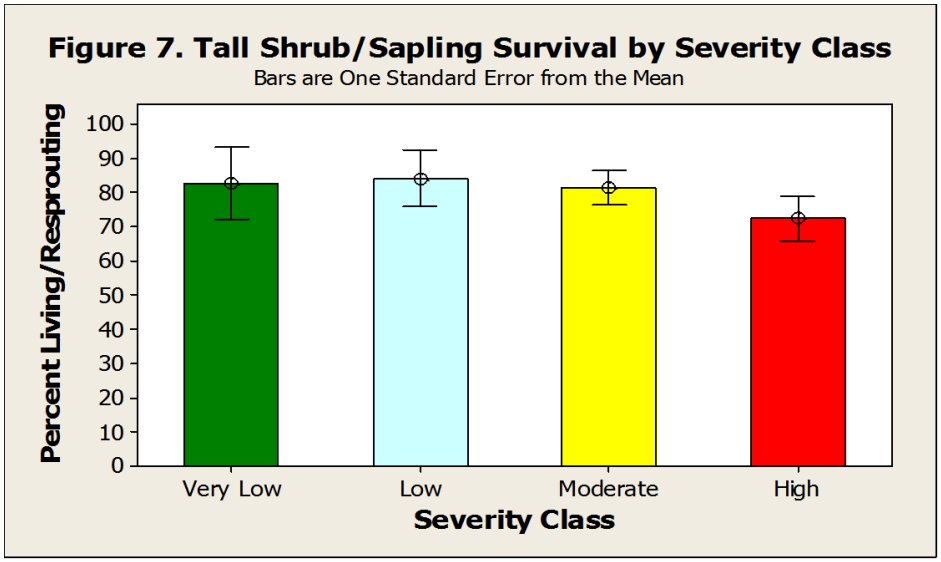
Moderate Severity

First Growing Season Post-Fire

High Severity

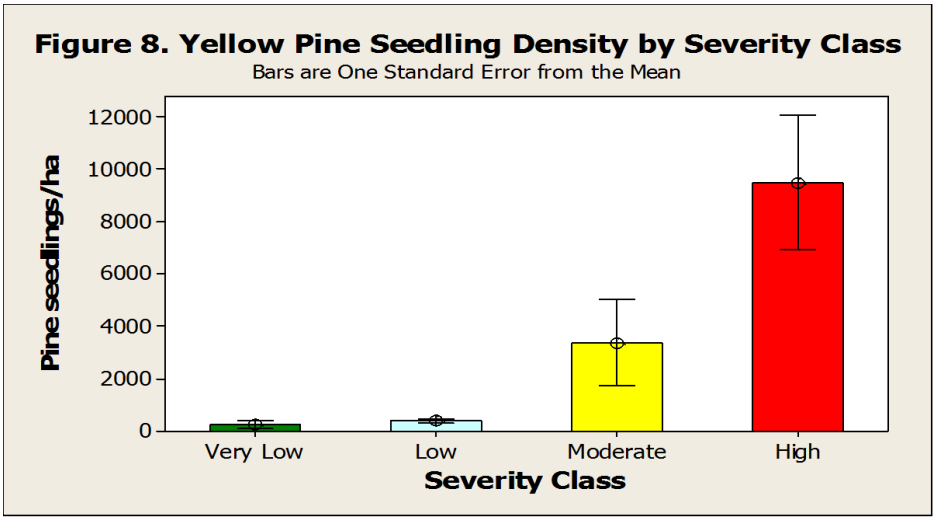
First Growing Season Post-Fire

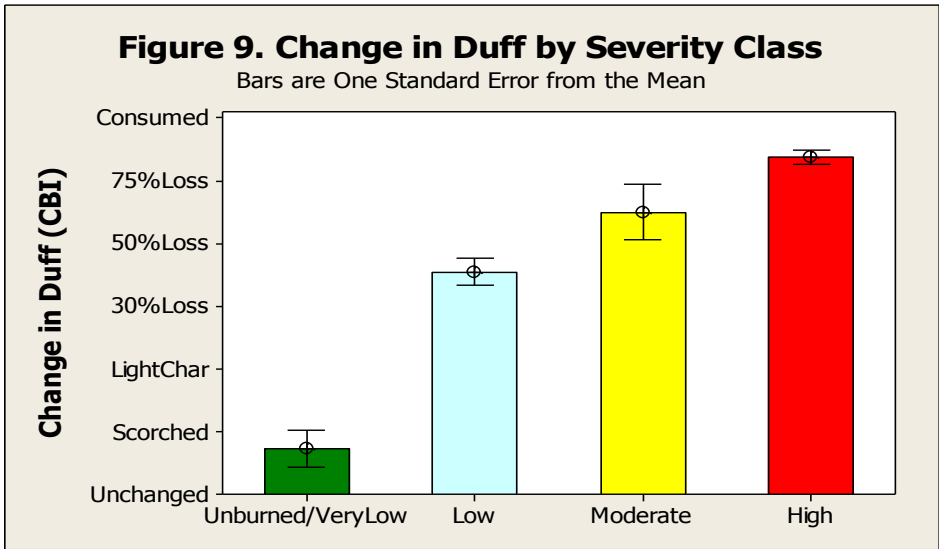




A distinctive feature of the vegetation response to this wildfire is the mass reproduction of *Pinus pungens* (Table Mountain pine – a serotinous species) and *P. rigida* (pitch pine). Seedlings of these two species were recorded in the herb layer in all severity classes, but large numbers were ubiquitous in moderate and high-severity sites (Fig. 8).

Another distinctive feature of the CT2 wildfire is the dramatic consumption of wildland fuels. This may be best signified by the reduction of forest duff, which comprises the heaviest fuel load in several GRSM forest types, and which was substantially reduced in three of the four severity classes (Fig. 9).





Discussion

Though burn severity mapping techniques have been well developed for the western U.S. and several other countries, few studies have been completed in the temperate deciduous and mixed forests of the eastern United States (3,4). Preliminary results from this study illustrate the utility of FIREMON Landscape Assessment methods for mapping and describing landscape and stand level fire effects in this region.

Such products can, in turn, be used to support a variety of management or research applications. For example, the high levels of tree mortality and duff reduction in high severity sites can result in increased incidence of exotic plant invasions, making the severity map a useful tool for weed management crews.

Future direction includes completing a second season of CBI and vegetation data collection, then using the increased sample size to conduct a more rigorous analysis. The longer term goal is to

develop a predictive landscape model coupled with stand-level severity class descriptions that can be reliably applied to other fires in similar habitats.

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Long Term Monitoring Results

There have historically been several monitoring types at GRSM, but the sustained focus of the program, and the vast majority of data collection, has occurred within the *Yellow Pine Woodland* and *Dry Oak Forest* monitoring types. Updates for the analyses of key management objectives have been completed for both of these monitoring types, and the results are provided in **Table 1**, below. Herbaceous cover is the only variable not updated for this report, due to time constraints. These analyses should be completed in the coming year.

Because the key fire-effects results are tied to long term objectives, and because all plots are still in the restoration phase (i.e. no plots have burned 4 times), we cannot say with any statistical certainty whether the prescribed burn program is meeting those long term objectives. However, trends in the data are provided, and can be used to gauge the ongoing effectiveness of the program at meeting objectives. In general, the current analysis suggests that the GRSM prescribed burn program is making outstanding progress.

In addition to long-term trends, monitoring and analysis of shorter-term objectives is typically completed for individual burns; this monitoring has been presented in post-fire FEMO reports and within past annual reports. These short-term analyses, coupled with longer-term trends in the data, provide the best way to evaluate program effectiveness and movement toward desired conditions. These combined analyses are driving the recommendations for the frequency, timing, and intensity of prescribed burning. Finally, in the adaptive management design that is inherent in prescribed fire restoration, these data can also be useful for re-evaluating and adjusting objectives as more information about ecosystem response to burning becomes available.

Table 1. 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 (FPIRI1) ***29 Total Plots :*** *28 have burned once* *17 have burned twice* *5 have burned three times* *1 remains unburned*	**>50% Reduction in total fuel loading**	**Total fuel reduction:** After 1 burn (n=27): 34% (±7%) After 2 burns (n=16): 37% (±6%) After 3 burns (n=5): 15% (±26%)	**Insufficient data. *Objective may need to be revised.***	**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% (±1%) (n=23) After 1 burn (n=23): 11% (±4%) After 2 burns (n=9): 10% (±6%)	**Insufficient data.**	**2009**
Dry Oak Forest (FQUCO1) ***24 total Plots :*** *17 have burned once* *9 have burned twice* *5 have burned three times* *7 remain unburned*	**>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. *Objective may need to be revised.***	**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% (±2%) After 1 burn *(n=9)*: 4% (±2%)	**Insufficient data.**	**2011**

Kings Mountain National Military Park (KIMO): 2017 Fire Effects Monitoring Annual Report

Activity Summary

The fire ecology and fire effects team made three trips to KIMO during 2017. The ecologist, lead monitor, and assistant lead monitor all participated in the third-entry burn of North-Central in May. The team performed much of the interior ignition of the unit, and provided training for a FEMO trainee. Following the burn, the crew completed immediate post-burn monitoring of two Blackjack Oak Woodland plots within the unit. The ecologist and entire crew then returned in September to conduct long-term monitoring in the North-Central, North Brushy, and Saddleback burn units. The Lead Monitor made another trip in late October to work with KIMO staff on fuels treatment mapping and join a meeting with Dr. James Mathews to discuss restoration strategies for the rare Georgia Aster that is found in the Park.

The fire ecologist contributed data and represented KIMO during early development of the NPS Starfire program for the Appalachian-Piedmont Fire Management Zone. Starfire is a planning tool to prioritize and inform prescribed burning, fuels treatments, and wildfire management in NPS units. Other program support centered on creating, validating, and submitting maps from historical prescribed burns, fuel treatments, and wildfires. Providing accurate maps is a critical component of both wildfire documentation and fuels project management, and our efforts support the increased emphasis on fire mapping for all NPS units.

Review of 2017 Projects

Monitoring of the North-Central burn unit:

Most of the work during the September monitoring trip was focused on long-term plot monitoring and fire-effects mapping on the North-Central burn unit, which was burned for the third time on May 10, 2017. Both the eastern (old "Midway" burn unit) and western (old "Swale" unit) lobes of North-Central were surveyed, though the most notable fire effects were observed in the eastern lobe. A differenced-normalized burn severity (dNBR) map was created by the fire effects team prior to the visit (**Figure 1**). Our monitoring suggests that the map is a fairly accurate representation of both burn severity and current forest structure, and some of those structural conditions are described in **Figures 2-5**. Long-term results (11 years of monitoring) from the 2 North Central plots are provided in **Figures 6-8**.

In general, "very low" severity patches (green) are mature intact forest, with varying amounts of understory density. "Low" severity areas are characterized by open forested conditions with or without small canopy gaps, and very open understories. "Moderate" severity areas typically

have very-open to completely-open canopies with vegetation dominated by a mixture of woody sprouts, native grasses, and forbs. These areas are largely the result of canopy mortality that occurred during previous prescribed burning events. It is important to point out that the "Low" and "Moderate" areas may contain thousands of woody sprouts per acre, and can become dominated by sapling-sized woody sprouts without continued burning.

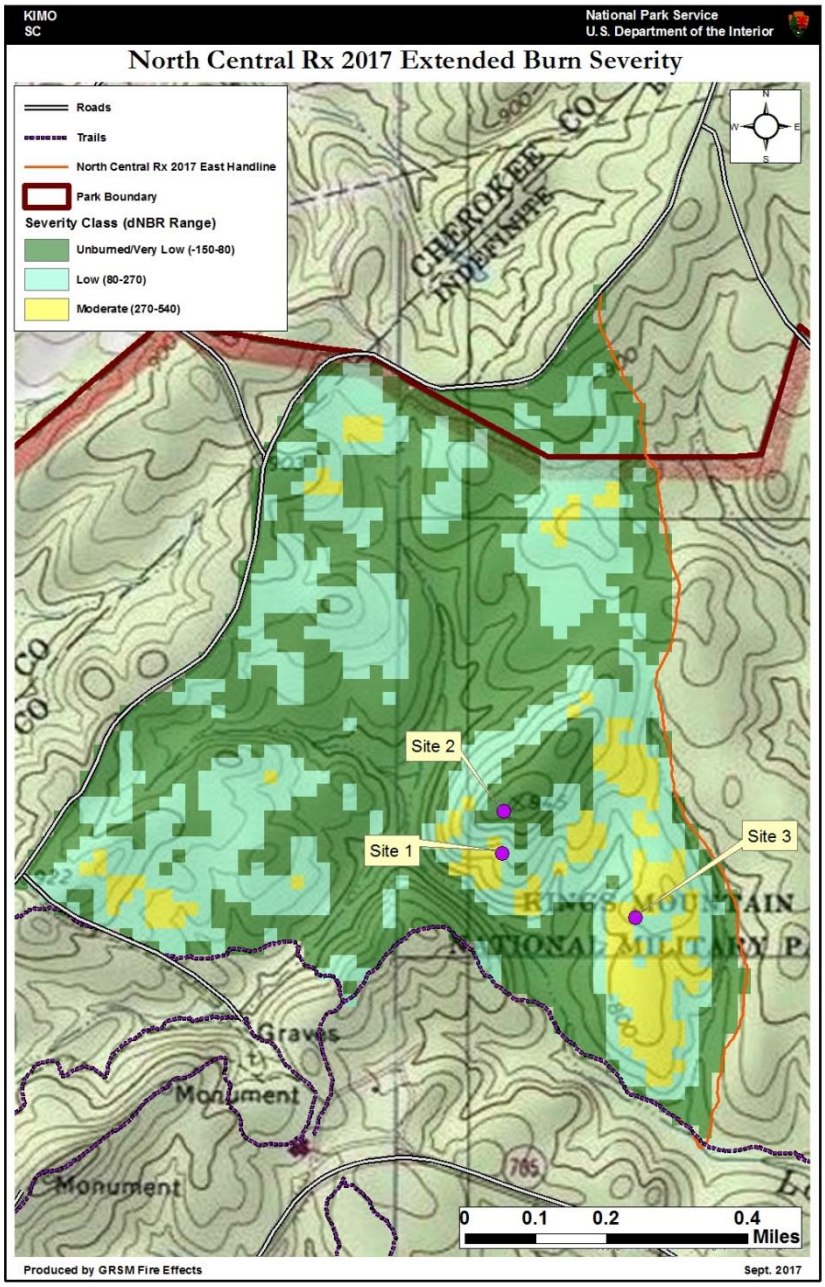


Figure 1. dNBR burn severity map of the 3rd-entry prescribed burn of North-Central. Sites 1, 2, and 3 are pictured in Figures 2-5.

Figure 2. Photo from Site 1 (looking west) from the burn severity map, taken immediately post-burn. Note the high coverage of the burn and high percentage of top-kill among tree sprouts.

Figure 3. Photo of Site 1, taken from the west - four months after the third burn of this site. Note the open conditions, high cover of bracken fern and little bluestem, and shortleaf pine saplings. This area was largely forested prior to the initial 2007 prescribed burn, but is now recognizable as a large patch of the rare (G2G3) Piedmont Rock Chestnut Oak-Blackjack Oak Woodland.

Figure 4. Ridgetop Chestnut oak forest - taken from site 2 and looking southeast. This depicts the "very-low" severity of this site (see map). More open and sunlit "Low severity" can be seen in the background.

Figure 5. Site 3 - Note the open woodland/savanna structure developing under a mature shortleaf pine canopy. The dominant grass is native broomsedge, likely indicating the agricultural history of this broad, flat ridge. This area was largely closed-canopy forest prior to the initial prescribed burning in 2007. Shortleaf pine is regenerating throughout this site.

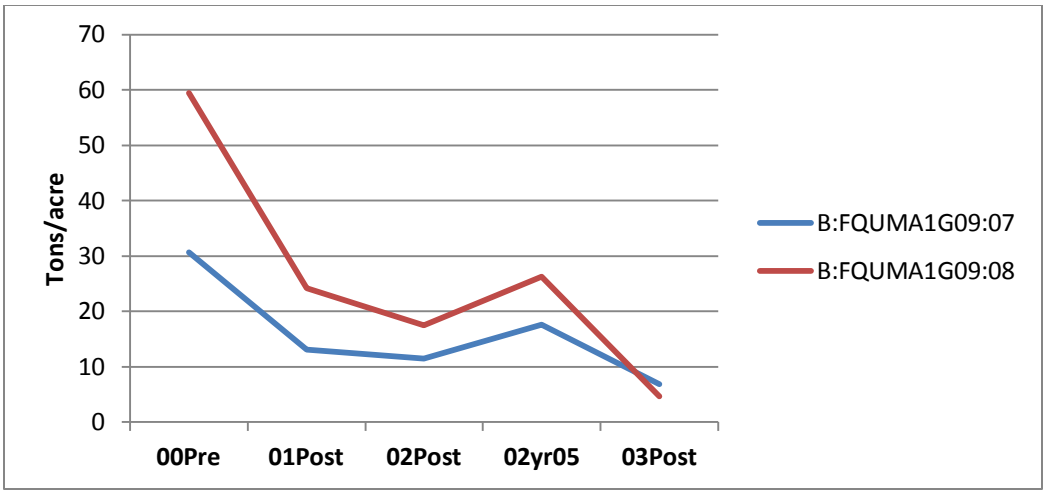


Figure 6. Change in total fuel loading for North-Central monitoring plots. Chestnut oak-Blackjack oak monitoring type.

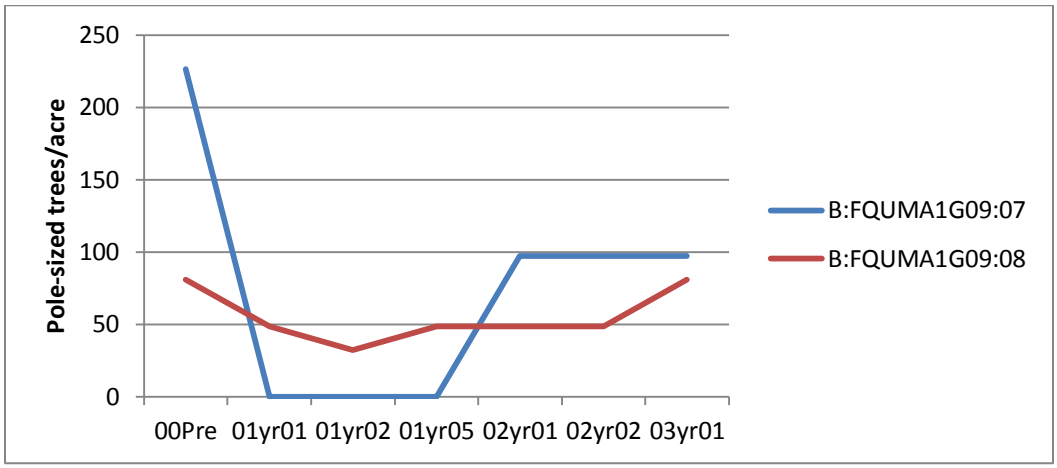


Figure 7. Change in pole (trees < 15cm dbh) density for North Central plots.

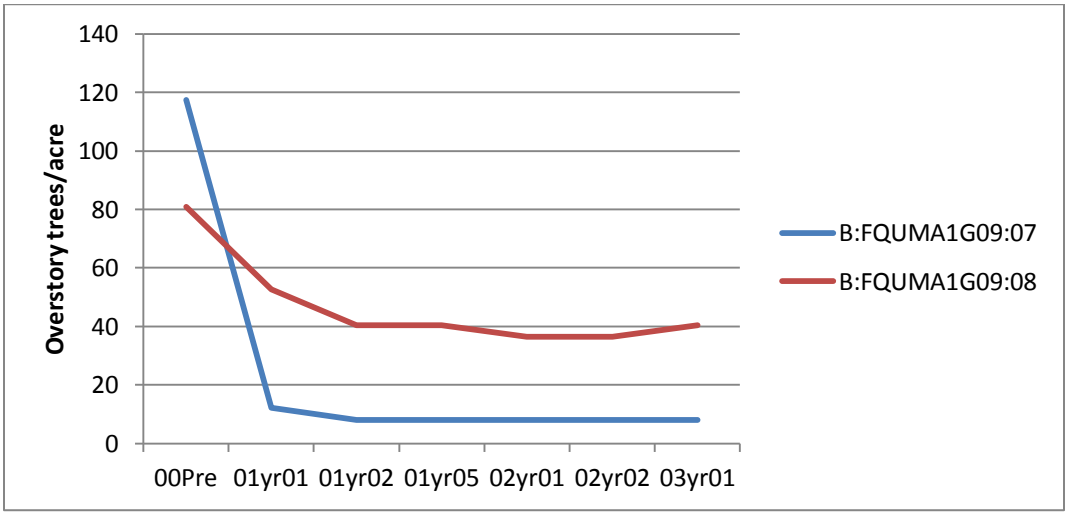


Figure 8. Change in overstory tree density for North Central plots.

Long Term Monitoring Results

There have historically been two monitoring types at KIMO: *Dry Oak Forest*, and *Chestnut Oak-Blackjack Oak Woodland*. Updates for the analyses of key management objectives in the *Dry Oak Forest* type have been completed for both of these monitoring types, and the results are provided in **Table 1**, below. Updates for herbaceous cover data are the only variable not updated at this time, due to time constraints. These analyses will be completed in the coming year. Results for the *Chestnut oak-Blackjack Oak Woodland* also need to be updated, and these analyses should be possible in the coming year. A subset of plot results from that monitoring type are included in the review of the North-Central prescribed burn unit in this report.

Because the key fire-effects variables are tied to long term objectives, and because most plots are still in the restoration phase (i.e. only 7 plots have burned 4 times), we cannot say with statistical certainty whether the prescribed burn program is meeting those long term objectives. However, trends in the data are provided, and can be used to gauge the ongoing effectiveness of the program at meeting objectives. In general, results from the dry oak monitoring type indicate that objectives for fuel reduction and tree density are being achieved.

The objective for oak seedling density in the Dry Oak Forest monitoring type needs to be re-evaluated for inclusion of shortleaf pine seedlings as a desired result. It is likely that a subset of the original "oak" plots should be managed for shortleaf pine regeneration instead of solely for oak regeneration. This is not the case for all plots identified as "oak" plots, but rather for those that have shortleaf pine as a codominant in the existing canopy. This analysis is currently underway, and may have implications for other long-term objectives and burning techniques.

In addition to monitoring of long-term objectives, monitoring and analysis of additional fire effects and shorter-term objectives is typically completed for individual burns; this monitoring has typically been presented in post-fire FEMO reports and within annual reports. The reporting on the results of the North-Central Rx in this year's report is an example of this type of monitoring. These short-term analyses, coupled with longer-term trends in the data, provide the best way to evaluate program effectiveness and movement toward desired conditions. These types of combined analyses are driving the recommendations for the frequency, timing, and intensity of prescribed burning. Finally, in the adaptive management design that is inherent in prescribed fire restoration, these data can also be useful for re-evaluating and adjusting objectives as more information about ecosystem response to burning becomes available.

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
Dry Oak Forest (FQUMO1) ***21 plots:*** *20 have burned once* *19 have burned twice* *17 have burned 3 times* *7 have burned 4 times*	**>50% Reduction in total fuel loading**	**Total fuel reduction:** After 1 burn (n=19): 40% (±6%) After 2 burns (n=18): 46% (±5%) After 3 burns (n=17): 57% (±5%) After 4 burns (n=7): 61% (±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) ***8 plots***	**>50% Reduction in total fuel loading**	**Total fuel reduction:** After 1 burn (n=7): 47% (±4%)	**Insufficient data.**	**2009**
	>70% Reduction in pole-sized tree density	**Pole reduction:** After 1 burn (n=8): 45% (±12%) After 2 burns (n=4): 62% (±12%)	**Insufficient data.**	**2009**
	15-30% Reduction in overstory tree density	**Overstory reduction:** After 1 burn (n=8): 30% (±11%)	**Insufficient data.**	**2009**
	>30% Cover by native herbs	Preburn cover (n=7): 6% Cover after 1 burn (n=7): 9%	**Insufficient data.**	**2009**

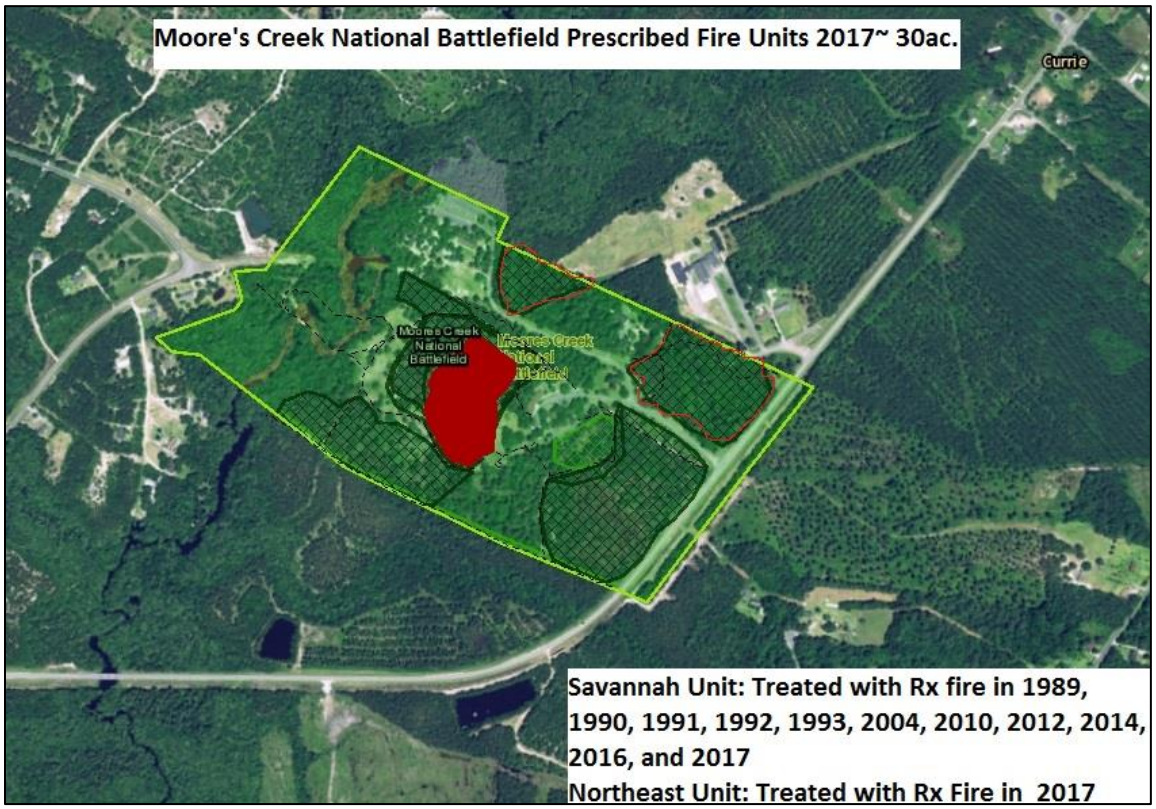
Moore's Creek National Battlefield (MOCR): 2017 Fire Effects Monitoring Annual Report

Activity Summary

The fire ecologist contributed data and represented MOCR during early development of the NPS Starfire program for the Appalachian-Piedmont Fire Management Zone. Starfire is a planning tool to prioritize and inform prescribed burning, fuels treatments, and wildfire management in NPS units. Other program support centered on creating, validating, and submitting maps from historical prescribed burns, fuel treatments, and wildfires. Providing accurate maps is a critical component of both wildfire documentation and fuels project management, and our efforts support the increased emphasis on fire mapping for all NPS units.

Review of 2017 Projects

No member from the fire ecology/fire effects team was present for the 2017 prescribed burning at Moore's Creek, and no FEMO report was filed. The map below provides basic documentation of the areas burned, which will be important data for any subsequent monitoring efforts. In the map, the Savanna unit is solid red, and the Northeast Unit is depicted with a red outline.



Additional Program Information

Table 1. Planning - 2017

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 2017)	Assisted with how many BAER plans in 2017?
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 - 2017

Park	% 2017 Data entered	%2017 Data Quality Checked	# of Prescribed Fires Monitored	# Non-Fire Fuels Treatments Monitored	#Wildfires Monitored	#BAER Treatments Monitored
BISO	100	75	1	0	1	0
BLRI	n/a	75	0	0	0	0
CAHA	n/a	n/a	0	0	0	0
CONG	100	75	1	1	0	0
COWP	n/a	n/a	0	0	0	0
CUGA	100	75	0	0	0	0
GRSM	100	75	2	0	3	2
KIMO	100	75	1	0	0	0
MOCR	n/a	n/a	0	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	0	1	0	Yes
CAHA	0	0	0	No
CONG	2	1	0	Yes
COWP	0	0	0	No
CUGA	0	1	0	Yes
GRSM	2	1	2	Yes
KIMO	1	1	0	Yes
MOCR	0	0	0	No

Table 4. Research - 2017

Park	Are research needs identified in FMP or Monitoring Plan? (yes or no)	# of Proposals Submitted in 2017	# of Proposals Funded in 2017	# of Research Projects Supported in 2017*	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	1	1	4	
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 2017 Accomplishments/Focus Areas

Category	Percent Time	Accomplishments and/or areas of activities
Data Collection	20%	Field work at GRSM, CUGA, BISO, and KIMO. FMH plots, LFEM plots, and qualitative surveys. Heavy work load at GRSM.
Planning	10%	Fire effects program planning. AP Zone planning (senior staff discussions), Starfire
Data analysis	10%	Analysis of Chimney Tops 2 monitoring data for AFE poster presentation. Work completed on 2016 Annual Report.
Data management	5%	Routine data management tasks
Supervision/Admin	10%	Budget/Realignment issues. Hiring, Supervision, Performance evaluations, Training, IDPs, travel, payroll, crew support, purchasing etc.
Fire Operations	5%	Wildfires at CHAT and GRSM. Prescribed burns at GRSM, BISO, and KIMO.
Writing	5%	Work on publications. Proposal writing. Annual report. Detailed correspondence.
Educational Outreach	25%	Numerous oral presentations, field trips, and media interviews were prepared and provided to Park staff, NPS partners, and the public. GRSM All Employees presentations, Resource Education Training, Seasonal Ranger Training, Tremont Institute Field Trip, Highlands Biological Station Class Field trip, Teacher Workshop (full day), VIP field trip, FLN presenter, Wildflower Pilgrimage primetime presentation, Experience Your Smokies presentation, TNC field trip, CAFMS field trip, interviews by Garden & Gun, Smoky Mt. Living, Chattanooga Free Times Press, Smokies Life Magazine, UT Today, Smokies Guide, BearPaw, Eco-Report Bloomington, and a few others.
Partnerships	4%	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	4%	Completed Landscape Conservation Forecasting Report for GRSM, 2 publications in collaboration with USFS SRS (using NPS monitoring data from numerous eastern parks), collaboration with Clemson on multi-park fire effects analysis
Miscellaneous	1%	Mostly communication; E-mails, phone calls, informal planning discussions. Zone fire mapping workshop with Justin Shedd
Training	1%	Supervisory and required NPS training; fire refresher

Table 2. Fire Effects Crew 2017 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
Qualitative Monitoring	5%	Completed Qualitative monitoring at BISO and GRSM
CBI plots/Landscape Fire Effects Monitoring (LFEM)	20%	Long term LFEM plots at GRSM CT2 WF(permanent plots) and completed all LFEM plots within the mastication area of CONG(Harry Hampton-6 total)
Wildfire assignments	5%	Lead –READ assignment on BICY on Cowbell Complex. HECM for Type3 helicopter on multiple Wildfires in Montana. LEAD and Assistant Helped with May 6th Wind Event at GRSM
Prescribed fire projects	15%	Assisted with implementation and mop-up of burns at BISO, CONG, GRSM, KIMO,
Non-fire fuels projects	< 5%	Collected data for 6 of 17 CONG mastication plots
Travel out-of-park for plot or project work	<5%	Lead and Crewmember assisted Mississippi Zone with Fire Effects
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	17%	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 attended HEQB training, Grass workshop at Highlands Biological Institute, and Chainsaw refresher training at Congaree National Park. Crewmember attempted to attend TREX NorCal but wildfires did not permit the training to happen.
Miscellaneous	<1	

Program Direction for 2018

Program direction for the coming year primarily consists of continuing with the focus areas of the past 5-10 years:

- collection and reporting of the highest priority data for multiple parks
- utilization of a variety of complementary monitoring tools
- maintaining partnerships and an eastern fire ecology network
- full engagement in prescribed fire operations and support for all fire operations.

Additional areas for program improvement and focus include better data management, QA/QC enhancements, and monitoring plans. Goals for the coming year include progress in each of these areas, as time and staffing allow.

One final goal for 2018 is to conduct a more comprehensive analysis and report of 20 years of Appalachian fire-effects results. Combined data from GRSM, BISO, CUGA, and KIMO represents a much larger sample size than any of these parks alone; with great similarities of vegetation, fuels, resource objectives, and fire effects – such an analysis would be of tremendous value to any manager doing prescribed fire restoration in this region.

Data Entry Status and FFI suggestions

Program Data

1. FFI databases for which no new data were collected this year:
    - BLRI
    - COWP
    - CAHA

2. Percentage of network **total** monitoring program data (including past and present data) that has been entered into FFI, or another application, and quality checked -
    - 97% (92% FFI, 5% Excel)
    - 3% still in paper format is qualitative assessments and exotic plant data

3. Data migration needs?
    - Our herbaceous nested quadrat data was migrated into FFI by Caratti Analytics; however there was an apparent miscommunication about the desired structure for the newly created database that rendered the migrated data practically unusable. The usable data are still in MS Excel, but a more carefully designed migration would be desirable.

4. FFI/FFI Lite problems: Cover-points data collection (50m herb transects) is not functional for tablet data collection in FFI Lite. We are currently working on a problem description.

The End.