



National Park Service Mississippi River Zone/Barrens to Bayous Fire Ecology Annual Report Calendar Year 2018

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A. Summary

2018 was a transitional year for the Mississippi River Zone (MRZ) Fire Ecology program, as the program paused plot monitoring efforts to reevaluate monitoring objectives, scheduling, and protocols. The Fire Effects crew was at reduced capacity with only 1 or 2 staff at a time, however the program still completed a wide variety of fuels and ecological fire projects.

Accomplishments include:

- Assisted with 9 prescribed fire treatments for 2,923 acres at the following parks:
 - Horseshoe Bend National Military Park (HOBE)
 - Gulf Island National Seashore (GUIS)
 - Stones River National Military Park (STRI)
 - Big South Fork National Recreation Area (BISO)
 - Little River National Preserve (LIRI)
 - Natchez Trace National Parkway (NATR)
- Participated in 3 wildfires including Cynthia Worthington at the Mendocino Fire.
- Extensive database reorganization.
- Implementation of new photograph technology including 360 degree camera.
- Developed new mobile data collection methods including ArcGIS Online maps, Collector, and....
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Throughout the year, the crew worked with network parks Resource Management staff and cooperators on projects such as:

- Assisted HOBE with response to Southern Pine Beetle outbreak by scouting and marking treatment areas. Assisted felling trees to create a buffer to protect remnant pine trees and neighboring property.

- Targeting high priority restoration areas for sites currently managed with fire in need of further fuels reduction or additional management interventions such as the Black Belt Prairie at NATR.
- Developed a predictive model for suitable habitat and mapped reintroduction sites for the Price's Potato Bean (*Apios priceana*) for a PMIS funded project.
- Assisted interpretation staff to design and execute a seasonal display highlighting Black Belt restoration at NATR with narrative of ecological imbalance created by the invasion of Virginia red cedar (*Juniperus virginiana*), graphical data showing cedar reductions achieved using fire and mechanical treatments, and before and after comparative photos.

The new objectives developed for several parks are being monitored concurrently with previously developed objectives prior to retiring them in order to compare the efficiencies, effectiveness, and results.

Table 1. Fire Effects Plot Workload (2018) and Total Plots Installed

Park	Monitoring Type	Type Code	Plot Type	Pre-burn	Immed. Post	Annual	Annual Total	Total Plots
Cumberland Island National Seashore	Mixed Loblolly Pine Plantation	PLAN	Fuels Plot	0	0	0	0	0
	Longleaf Pine – Darlington Oak – Wiregrass Woodland	ARIS	FMH Forest Plot	0	0	0	0	0
Gulf Islands National Seashore	Sand Pine - Scrub Oak	PICL	FMH Forest Plot	0	0	0	0	0
	Longleaf - Slash Pine	PIPA	FMH Forest Plot	0	0	0	0	0
	Pitcher Plant Savannah	SAAL	FMH Forest Plot	0	0	0	0	0
	Fuels Monitoring	FUELS	Fuel Plot	0	0	0	0	0
Mammoth Cave National Park	Redcedar – Oak Glade	JUVI	FMH Forest Plot	0	0	0	0	0
	Indiangrass Grassland	SONU	FMH Grass Plot	0	0	0	0	0
	Big Bluestem Grassland	ANGE	FMH Grass Plot	0	0	0	0	0
	Oak-Hickory Woodland	OAHI	FMH Forest Plot	0	0	0	0	0
	Chestnut Oak Woodland	QUMO	FMH Forest Plot	0	0	0	0	0
	Fuels Monitoring	FUELS	Fuels Plot	0	0	0	0	0
	Old Field	OLFI	FMH Forest Plot	0	0	0	0	0
Little River National Preserve	Shortleaf Pine Forest	PIEC	FMH Forest plot	0	0	0	0	0
	Green Pitcher-plant Bog	SAOR	FMH Forest Plot	0	0	0	0	0
	Mary's Fire		CBI	0	0	0	0	0
	Chestnut Oak Forest	QUMO	FMH Forest Plot	0	0	0	0	0
Natchez Trace Parkway	Oak-Hickory Woodland	OAHI	FMH Forest Plot	0	0	0	0	0
	Post Oak Savanna	QUST	Mod. F. Plot [†]	0	0	0	0	0
	Redcedar Encroached Prairie	JUVI	FMH Brush Plot	0	0	0	0	0
	Loblolly Pine Forest	PITA	FMH Forest Plot	0	0	0	0	0
	Redcedar Encroached Prairie	BLACK BELT	FMH Grass Plot	0	0	0	0	0
	Potato Bean Woodland	APR	Rare Plant	0	0	1	0	1
	Tennessee Barrens	TNBA	Mod. F. Plot [†]	0	0	0	0	0
	Japanese Grass Invaded Streamside Forest	MIVI	FMH Grass Plot	0	0	0	0	0
Horseshoe Bend NMP	Mixed Montane Longleaf Forest	PIPA	FMH Forest Plot	0	0	0	0	0
Stones River National Battlefield	Little Bluestem Fields	SCSC	FMH Grass Plot	0	0	0	0	0
	Central Basin Barrens	ANTE	FMH Grass Plot	0	0	0	0	0
	Grassland Restoration Areas	ANVI	FMH Grass Plot	0	0	0	0	0
	Fuels Monitoring	FUELS	Fuels Plot	0	0	0	0	0
	Redcedar Woodland	JUVI	FMH Forest Plot	0	0	0	0	0
Russell Cave NM	Chestnut Oak Forest	QUMO	FMH Forest Plot	0	0	0	0	0
Vicksburg NMP	Exotics Monitoring	VICK	Photo Plot	0	0	0	0	0
Shiloh NMP	Oak-Hickory Woodland	OAHI	FMH Forest Plot	0	0	0	1	1
Total				0	0	0	1	1*

Table 1. Fire Effects plot workload

Table 2. Fire Ecology Staffing 2018

Ecologist and Monitors	Starting Date	Ending Date	# of Pay Periods	READ Qualified (Yes or No)	Training and Development
Bob Boensch	01/01/2018	12/31/18	26	No	READ Course, ESRI online GIS training
Meghan Whitman	04/09/2018	12/31/18	13	No	READ Course, ESRI online GIS training, S-212
Cynthia Worthington	03/18/2018	10/14/18	14	Yes	Women and Leadership Conference

Table 2. Fire Ecology staffing 2018

2018 Management Objectives and Monitoring Results

Zone Parks

Without the collection of significant new data in 2018, many of the long term monitoring results remain unchanged from the extensive data analysis completed in the 2017 report. Fire management objectives are currently being reconsidered and revised for several parks this year with collaboration from representative staff.

Litter and duff data were reexamined to determine why objectives to reduce these layers have not been achieved with burning. Post Burn Severity data was used to classify and reorganize the litter and duff data to analyze separately. While the Severity Classes may be considered more qualitative than quantitative, the unburned Severity class 5 serves as a useful category to compare to other classes.

Species Richness Estimates were examined for select parks to determine their utility for monitoring fire effects. The Chao1 estimates contained within this report are derived using the methods described by Anne Chao in “[Deciphering the enigma of undetected species, phylogenetic, and functional diversity based on Good-Turing theory](#)”. The Good-Turing formula is based on the work of Alan Turing which was developed to estimate the true frequencies of rare and still-undetected code elements. This method of analysis enabled Allies to successfully crack intercepted German Enigma code during WWII. This formula can be applied to provide a species diversity estimate that also accounts for undetected species within an incomplete sample.

Cumberland Island National Seashore (CUIS)

A main objective for CUIS is immediate post-burn reduction of litter and duff. Short term reductions result from both low severity prescribed fire and natural decomposition; however achieving post-fire litter objectives without duff reduction are in conflict with longer term objectives to expose mineral soil. The Fire Ecology program examined which Post-Fire Severity Class best reduce the litter and duff layers and how long do those reductions have an effect? The following analysis looks at one year post burn data. Burn Severity Classes 2 and 3 showed litter reductions extended one year post burn, while only Burn Severity Class 2 showed reductions in duff one year post burn. This may indicate that to have a longer term reduction in both layers, prescribed fires may need to achieve these Burn Severity Classes from single burns or implement a short term annual burn cycle if possible. This data analysis resulted from the Stafford Plantation burn unit which contains four plots with four Planar Transects each.

Table. 3 CUIS Management Objectives and Monitoring Results

Monitoring Unit CUIS	Management Objective (Restoration)	Monitoring Results (80% confidence interval)	Objective Achieved?	Year Analysis Completed (Range of Data [Yrs] Included in Analysis)
Mixed Loblolly Pine Plantation (FPLAN1D09)	Decrease duff and litter loading by 40-90% as measured immediately post burn $\beta_{Post - before} \beta_{before}$ $\beta_{YR01 - Pre00}$ $Pre00$	Decrease in Duff = Post fire = +21.4% ($\pm 17\%$) n=4 1 Year after fire = 9% ($\pm 20\%$) n=4 Decrease in Litter = Post fire = 37% ($\pm 4\%$) n=4 1 Year after fire = 17% ($\pm 11\%$) n=4	No	2018 (1999-2017)

Table 3. CUIS Management Objectives and Monitoring Results

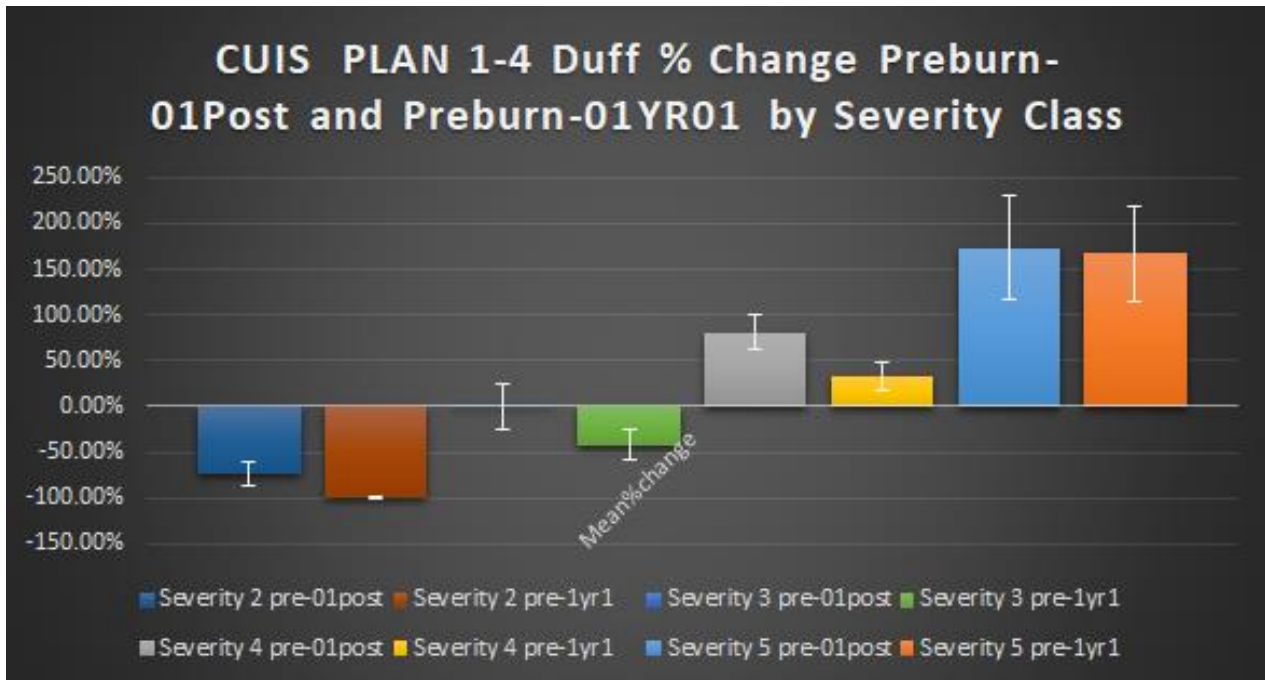


Figure 1 Looking into Duff responses separated by Post Burn Severity Class from Stafford Plantation at CUIS

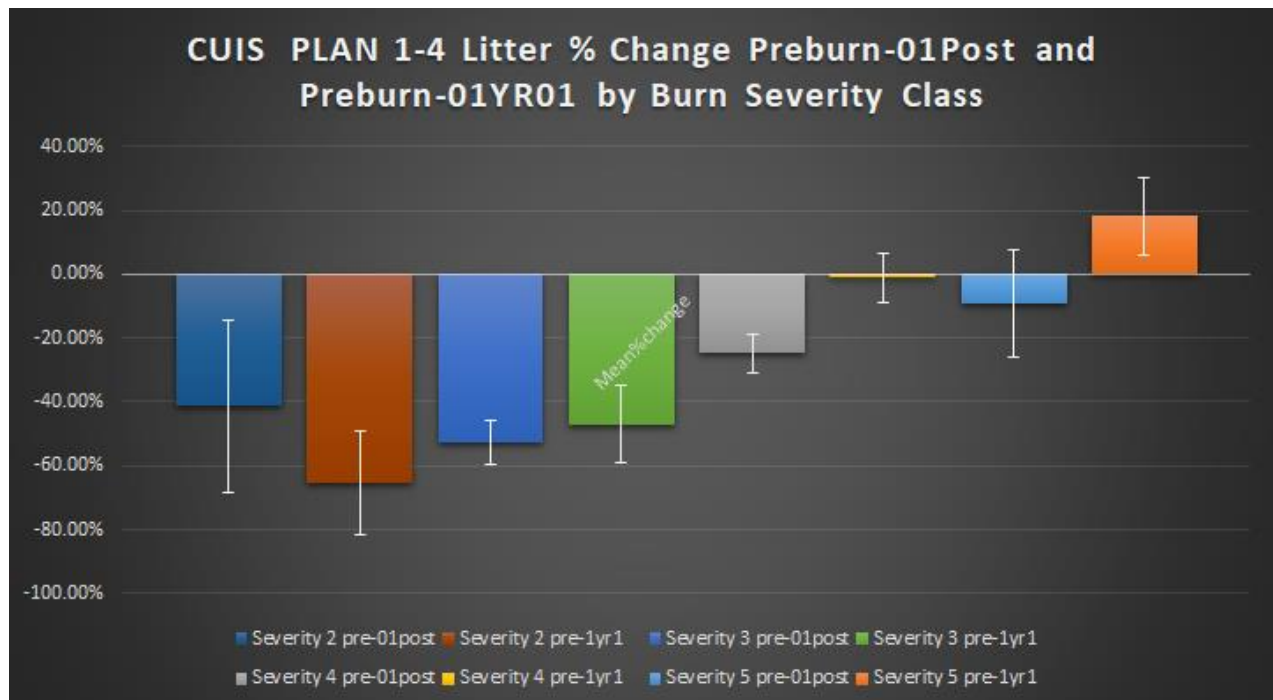


Figure 2 Looking into Litter responses separated by Post Burn Severity Class from Stafford Plantation at CUIS

Gulf Islands National Seashore (GUIS)

On March 8th and 9th, staff from the Mississippi River Zone treated burn units NLO 10 and NLO 7A with prescribed fire. The first burn in NLO 10 was near the Visitor Center and had no previously fire history (see map below). This unit had many remnant longleaf prior to experiencing several hurricanes and salt water intrusion which killed the majority of longleaf pine trees within NPS FMH plot (PIPA 08) located within the unit. Data had not been collected on this plot in 15 years and attempts to collect pre-burn data the day prior to the burn were unsuccessful due to dense palmetto vegetation. Fire Effects staff trialed a Garmin Virb 360 camera for pre and post burn photos along the road and through the east portion of the unit and took photos approximately every meter. These photos were also uploaded to Mapillary.com, which is a photo mapping website, since ArcGIS Online cannot display 360 degree spherical photos. The Fire Ecologist will continue to develop methods for 360 photo data display and analysis in 2019. The east portion of the unit was comprised sand pine and scrub oak vegetation. It had received over 1.5 inches of rain two days prior; however, the sandy soils allowed for quick drying and moderate levels of duff were consumed. Overall, post burn effects are best described as mixed severity with some duff consumed in a mosaic fashion.



Table 4. Prescribed fire map of NLO-10 Fire Management Unit



Figure 3. Photo taken near plot at 1257

The NLO 7A burn unit had a northern portion previously burned in 2017 (see map). Three FMH plots were located in this section which were comprised of patchy fuel that did not carry fire well. The southern portion, which did not burn the year previously, had significantly more active fire behavior. While the flames became high enough to scorch many of the overstory trees at times, the fire personnel were able to moderate the intensity by adjusting ignition techniques.

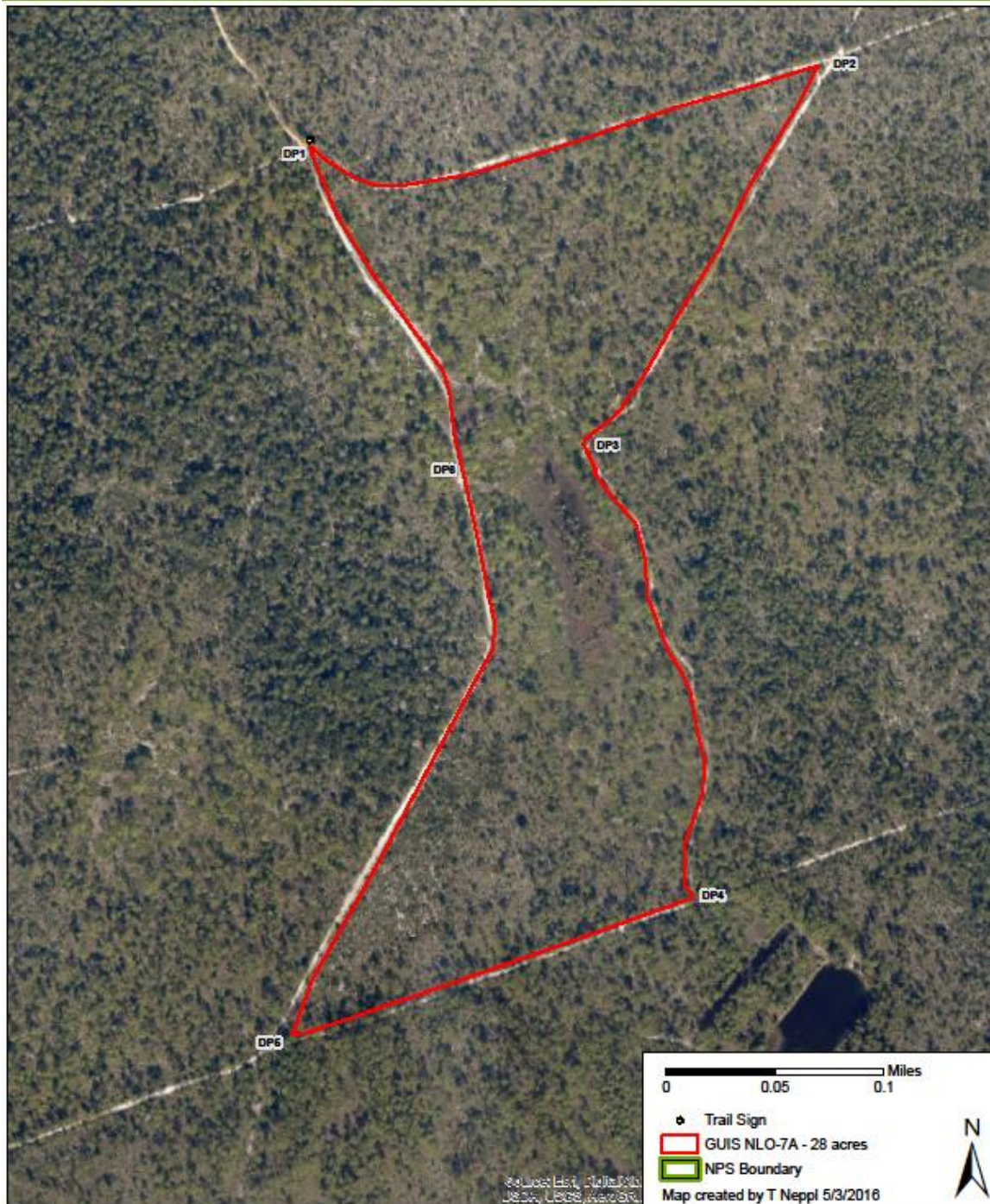


Figure 4. Map of NLO 7A Fire Management Unit



Figure 5. Tree torching on NLO 7A 03/09/2018

Horseshoe Bend National Military Park (HOBE)

On March 22, fire personnel from the MRZ, Southeast Regional Office, and the Appalachian Mountain Zone burned the Northeast units. This marks the fourth prescribed burn since fire management was initiated in 2003. The rolling topography found here includes remnant montane longleaf pine complimented with oak, hickory, shortleaf and loblolly pines. Decades of fire suppression has led to a significant buildup of litter and duff as well as an overabundance of bottomland, mesophytic trees and shrubs having gained a foothold along the upper slopes of the park.

Duff levels remain one of the highest concerns for HOBE since reducing it to mineral soil among the relic longleaf pine trees will be necessary to promote natural regeneration of the species. Below are an investigation of duff response to the severity of the prescribed fires. Post fire monitoring has utilized a burn severity scale along the planar transects (Brown's Lines) which enables the litter and duff measurements to be categorized within each scale. The scale is as follows: 1=Heavily Burned, 2=Moderately Burned, 3=Lightly Burned, 4=Scorched, 5=Unburned. While there may be some subjectivity between classes 2 through 4, there is none between the unburned class 5 and the remaining burn classes. Litter and fuels data are normally averaged together; however, we wanted to determine what effect was present when unburned portions of the Brown's line were excluded from analysis. The charts below may just confirm what some conclude to be obvious, but it may be helpful to prescribed fire practitioners to see that achieving the objective of duff reduction may require fire severity to be greater than the classification of scorched and in some cases require moderate burn severity at a minimum.

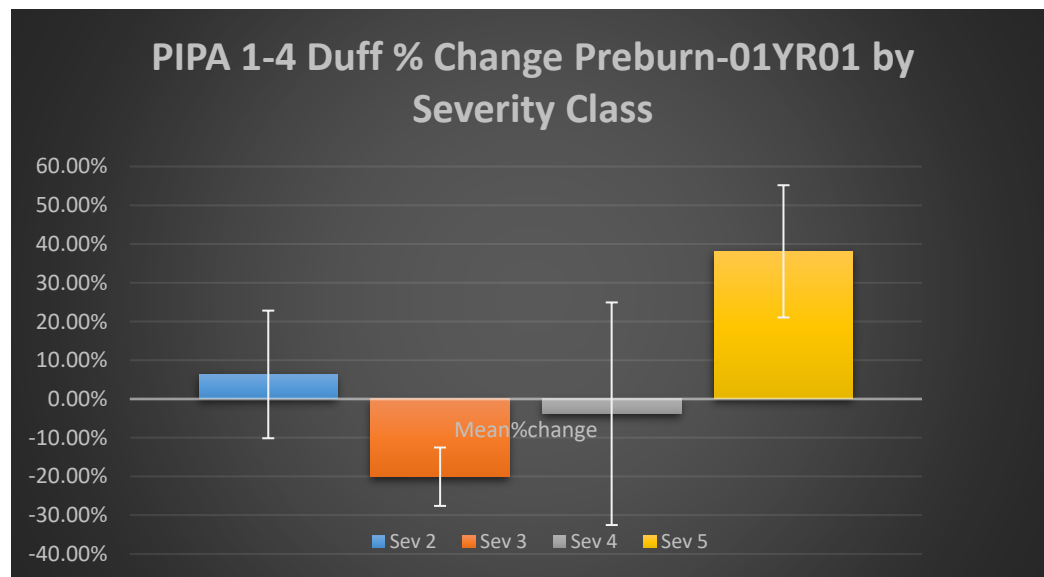


Figure 6. Percent change of duff comparing preburn vs. one year after the first burn categorized by fire severity class

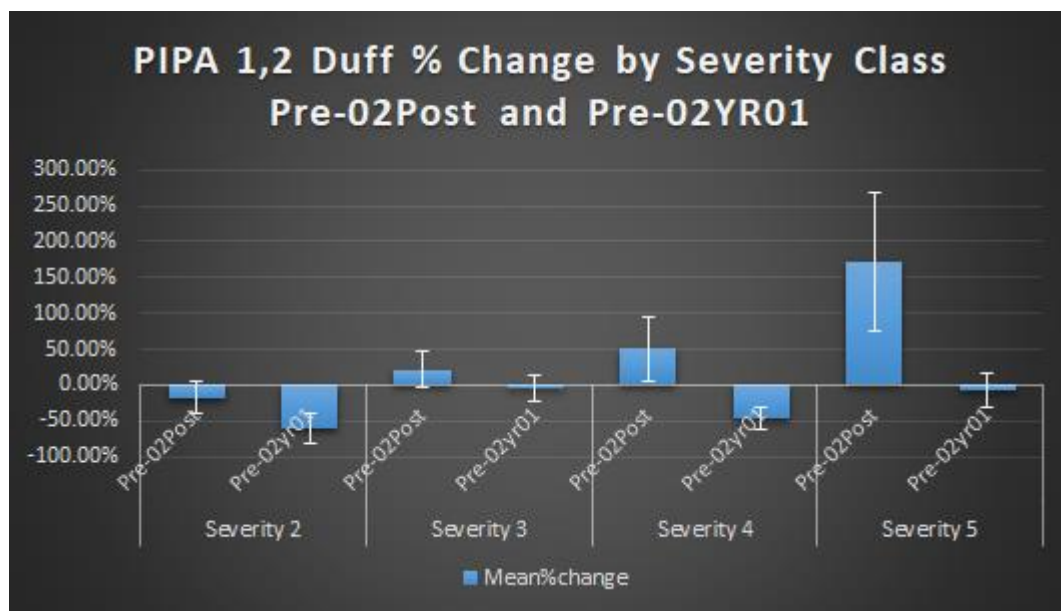


Figure 7. Percent change of duff in PIPA plots 1 and 2 comparing pre-burn vs. immediately after 2nd burn (Pre-02Post) and pre-burn vs. one year after 2nd burn (pre-02yr01) categorized by fire severity class

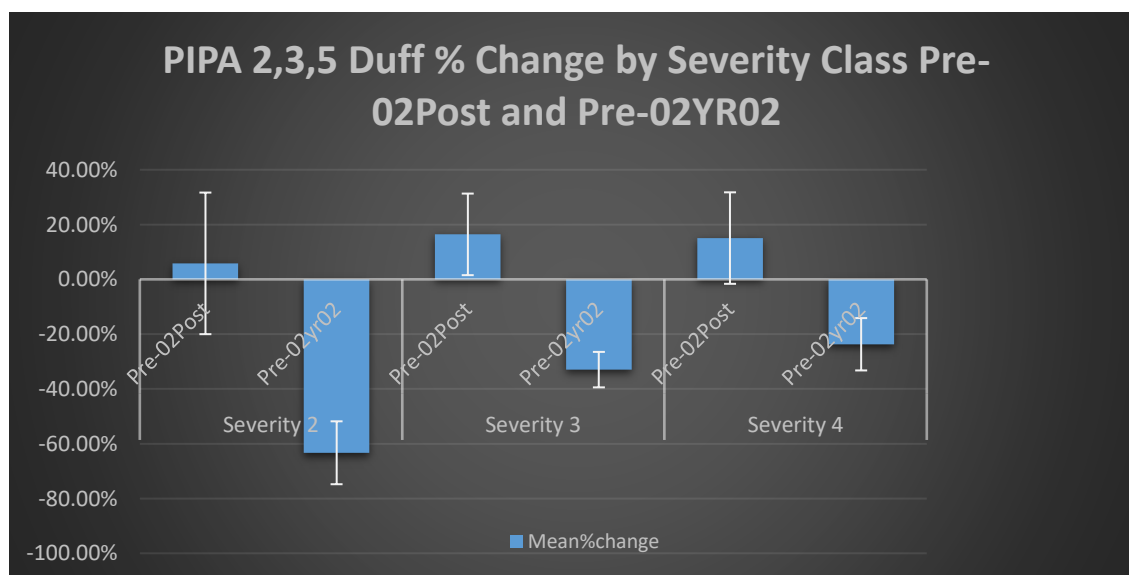


Figure 8. Percent change of duff in PIPA plots 2,3, and 5 comparing pre-burn vs. immediately after 2nd burn (Pre-02Post) and pre-burn vs. two years after 2nd burn (pre-02yr02) categorized by fire severity class

In order to meet the requirements for longleaf regeneration, the following is an example of refined prescribed burn and fire effects monitoring objectives for HOBE:

General Objectives HOBE – Additional objectives apply to each following monitoring type.

- Top-kill >50% of encroaching (mesophytic) woody species less than 2 meters immediately post-burn.
- Reduce canopy closure and/or basal area by >20% over 3 burn cycles (with focus on mesophytic woody species, where appropriate).
- Increase herbaceous species richness (average number of native species) and/or percent cover – Target >10% increase measured 2nd year after 2 periodic burn cycles.
- Expose mineral soil on >20% of site

Mixed Montane Longleaf Pine Forest

- Limit mortality of overstory longleaf pine (*Pinus palustris*) trees to less than 10% as measured 2 years post burn.
- Decrease duff depth by >10% as measured post burn.
- Facilitate natural regeneration of longleaf pine. Monitor cone production and report regeneration events to adjust prescribed fire schedule.

Long Term Objectives - When units move from restoration phase to maintenance phase.

- Greater than 50% reduction in total fuel loading
- Greater than 30% cover of native herbaceous species
- Less than 50% Canopy Cover in Mixed Montane Longleaf Pine Forest compared to pre-burn conditions

Little River Canyon Preserve (LIRI)

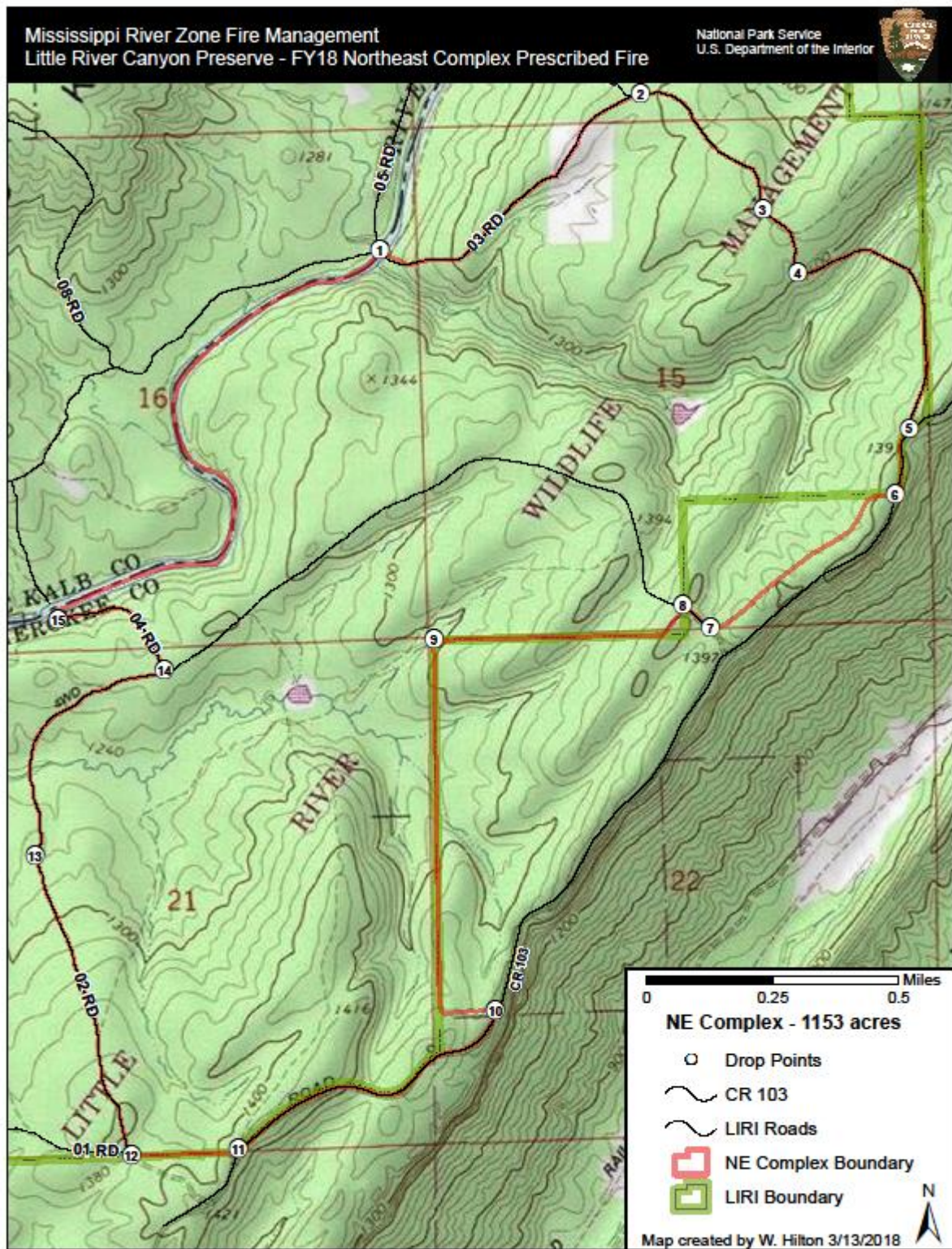


Figure 9. Burn unit map for Little River Canyon National Preserve NE Complex Fire Management Unit

The Northeast Complex is comprised primarily of shortleaf pine forest with variations mixed with oaks and loblolly pines. There are some artificially regenerated longleaf pine along the perimeter of the unit as well. The 2016 drought has led to notable mortality of overstory trees; however, the tree mortality is scattered and may promote more suitable conditions for the regeneration of shortleaf pine over time. Within the northeast portion of the 01-103 burn unit, NPS staff burned a total of 561 acres in a unit receiving its 3rd prescribed fire. This unit was planned to be treated for a total of 1153 acres, however fire personnel decided to reduce this unit to the northern portion in order to better mitigate the effects of smoke on nearby roads in anticipation of poor nighttime smoke dispersion predicted by the spot forecast. Fire intensities were mixed between low and moderate severity with only the top layer of the litter being consumed over the majority of the unit.



Figure 10. Example of burn severity ranging 4 (scorched) to 3 (lightly burned)

Patches of higher intensity were observed on trees scorched up to 7 feet in some areas.

On April 2nd, fire staff returned and completed the southern portion of this unit. Burn conditions were quite similar and the completed burned unit totals 1140 acres. One plot was selected for trialing 360 degree spherical photos. Two other photo-plots were installed to gather photographic data as well.

Table 5. SAOR 1, 2, and 3

(1) Summary of species data and richness estimates in each habitat							
Habitat	Sample size	f1	f2	Observed richness	Undetected richness	Chao1 richness	95% conf. interval
X00PRE	523	1 3	1 0	57	8	65	(59, 87)
X01YR0 1	488	1 1	1 3	53	5	58	(54, 72)
X02YR0 1	471	1 0	7	51	7	58	(53, 80)
X02YR0 2	470	1 4	1 0	55	10	65	(58, 89)
X03YR0 1	536	9	8	50	5	55	(51, 72)
X04YR0 2	619	1 4	1 0	56	10	66	(59, 90)
X05YR0 1	468	1 8	7	55	23	78	(62, 128)
Notes							
fr is the number of species each represented by exactly r individuals in the sample.							
Observed richness = observed species richness.							
Undetected richness = estimated undetected species richness.							
Chao1 richness = Chao1 species richness estimator.							
95% conf. interval = the lower and upper confidence limits for the species richness at 0.95 level.							

Table 5: Cover-Line Intercept Data from FMH SAOR 1,2,3 plots to create species richness estimate using Good-Turing formula.

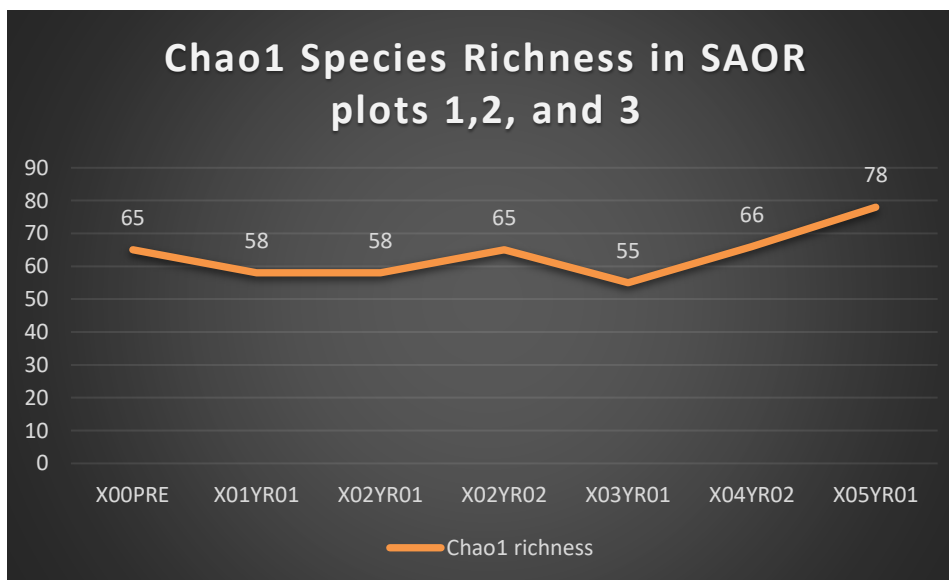


Figure 11. Species richness estimate using Good-Turing formula

Revised Objectives for LIRI

General Objectives LIRI – Additional objectives apply to each following monitoring type.

- Top-kill >50% of encroaching (mesophytic) woody species less than 2 meters immediately post-burn.
- Reduce canopy closure and/or basal area by >20% over 3 burn cycles (with focus on mesophytic woody species, where appropriate).
- Increase herbaceous species richness (average number of native species) and/or percent cover – Target >10% increase measured 2nd year after 2 periodic burn cycles.
- Expose mineral soil on >20% of site

Shortleaf Pine Forest

- Maintain fire frequency return interval 2-7 years within shortleaf pine stands.
- Promote natural regeneration of shortleaf pine - *Pinus echinata* – Monitor cone production and report regeneration events to adjust prescribed fire schedule.

Green Pitcherplant Bog Forest

- Maintain fire frequency return interval 1-3 years within the green pitcher plant bogs while maintaining >30% of fire managed habitat in two year rough condition. Favorable seasonality includes mid-late growing season.
- Increase number of Green Pitcher Plants – *Sarracenia oreophila* by >5% over 3 burn cycles.

Chestnut Oak Forest

- General objectives.
 - More in development, stay tuned
- RAP targeting burn units and pitcher plant sites

Natchez Trace Parkway (NATR)

On January 26th, 2018 MRZ staff burned the Chickasaw Village site which is one of the largest maintained Black Belt prairies along the Natchez Trace Parkway. This 91 acre prairie is characterized by calcareous soils that support tall-grass prairie plant communities and provides critical habitat for wildlife including pollinators. This marked the 12th burn since 2002. Fire effects plots are present within this unit near islands of dense eastern red cedar which have documented the reduction in dominance of this species to the benefit of the prairie. The results of the prairie restoration work have been ongoing for many years and include chainsaw clearing of cedar, herbicide treatments, and reseeding of native species.



Figure 12. JUVI 30 Pre-burn photo 2002 (rescanned from 35mm film slide)



Figure 13. JUVI 30 post 4th burn 2006



Figure 14. JUVI 30 one year after 6th burn, 2009



Figure 15. JUVI 30 Post 12th burn, 2018

Revised Objectives for NATR

NATR Objectives

General Objectives - Additional objectives apply to each following monitoring type.

- Top-kill >50% of encroaching (mesophytic) woody species less than 2 meters immediately post-burn.
 - Reduce canopy closure and/or basal area by >20% over 3 burn cycles (with focus on mesophytic woody species, where appropriate).
 - Increase herbaceous species richness (average number of native species) and/or percent cover – Target >10% increase measured 2nd year after 2 periodic burn cycles.
 - Expose mineral soil on >20% of site

Black Belt Prairie Objectives

- 25-50% reduction of redcedar (*Juniperus virginiana*) density after 5 years of burning

Midsouth Savanna Objectives

- Reduce over-story of Eastern Red Cedar (*Juniperus virginiana*) by > 50% after 3 burns

Shiloh National Military Park (SHIL)

Burns conducted at Shiloh National Military Park have many indications of moving towards positive ecological results. Management objectives are either already being met or are trending towards them. Few parks within the fire management zone have been able to achieve the duff reductions documented at SHIL. While no burning occurred here in 2018, East Branch Shiloh Creek burn unit was completed in December 2017 for its 2nd prescribed fire treatment. Qualitative assessments have noted that the herbaceous understory plant community is responding and that mid-story mesophytic tree species are being reduced. This will allow for better oak and hickory recruitment. Units are planned to be burned 3-4 times within a 10-12 year window of the first burn which exemplifies a restoration fire regime for this forest type.

Table. 6 SHIL Management Objectives and Monitoring Results

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (XX% confidence interval)	Objective Achieved?	Year Analysis Completed (Range of Data [Yrs] Included in Analysis)
Oak-Hickory Woodland/Forest	Reduce litter and duff load by 30-40%	Total litter reduction: Pre-01Post = 53% Pre-1 year post = +15% Pre-02Post = 8% Total duff reduction: Pre – 1 year post = 40% Pre-02Post = 41%	YES	2018 (2013-2018)
	Reduce mean density of pole-size trees (2.5-15cm dbh) by 20-30% after 3 burns	Total pole-size tree reduction: Pre-1 year post = 9% Pre-2 years post = 14.3%	Not yet, but trends are very positive	2018 (2013-2018)

Table 6. SHIL Management Objectives and Monitoring Results

Stones River National Battlefield (STRI)

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (XX% confidence interval)	Objective Achieved?	Year Analysis Completed (Range of Data [Yrs] Included in Analysis)
Barrens (ANTE 1D05)	Reduce cover of eastern red cedar and exotic species by 20-75% by 5 years post-burn	Reduction of red cedar: 00Pre-01YR01 = 4.6% 00Pre-02YR01 = 5.9% 00Pre-02YR03 = 12.8% 00Pre-03YR02 = 23% 00Pre-04YR01 = 9% (<i>n=8 plots, 1-4 fires</i>)	YES	2018 (2003-2018)
	Increase native herbaceous species cover and diversity by 20-75%.	Increase cover of Forbs: 00Pre-01YR01 = -3.8% 00Pre-02YR01 = -0.6% 00Pre-02YR03 = 502% 00Pre-03YR02 = 756% 00Pre-04YR01 = 571% (<i>n=8 plots, 1-4 fires</i>) Increase cover of Graminoids: 00Pre-01YR01 = -4.6% 00Pre-02YR01 = -5.9% 00Pre-02YR03 = -12.8% 00Pre-03YR02 = -23% 00Pre-04YR01 = -9% (<i>n=8 plots, 1-4 fires</i>)	YES NO See further analysis with Chao1 Species Richness Estimator	2018 (2003-2017)
Schizachyrium scoparium SCSC	Increase native herbaceous species cover and diversity by 20-50%	Percent change in Forbs: Pre-1yr1 (n=11) = 9.3% 1yr1-2yr1 (n=2) 88% 1yr3-3yr1 (n=2) 152% Percent Change in Graminoids: Pre-1yr1 (n=11) = 9.7% 1yr1-2yr1 (n=2) = 5.8% 1yr3-3yr1 (n=2) = 9.5%	YES* *Need to examine issue of graminoids and diversity.	2018 (2003-2017)

Table 7.STRI Management Objectives and Monitoring Results

The objective for reducing red cedar has been met, but just barely. Additional treatments will continue to make a difference. The forbs within these plots declined one year after the first burn and again one year after the second burn. Three years after the 2nd burn they exploded over 500% and again two years after the 3rd burn they reached over 750% compared to pre-burn conditions. This may be indicative of a multi-year lag time of a favorable response to prescribed fire.

The graminoids have not fared as well with consistent declines in percent cover compared to pre-burn levels. While this may be of concern, using a different analysis showed that species richness has increased. The following Chao1 species richness estimate is created using the Good-Turing formula. The initial decline of species richness subsequent to a first entry fire is typical since fire intolerant species decline; however, fire adapted vegetation becomes stimulated and more herbaceous species become detected. This trend is evidenced by the response of the forbs following the 2nd and 3rd prescribed fire treatments.

(1) Summary of species data and richness estimates in each habitat-ANTI 1-8 over time							
Habitat	Sample size	f1	f2	Observed richness	Undetected richness	Chao1 richness	95% conf. interval
X00PRE	1491	19	7	69	26	95	(77, 149)
X01YR01	991	11	12	51	5	56	(52, 71)
X02YR01	1053	16	7	52	18	70	(57, 112)
X02YR03	936	26	10	73	34	107	(86, 163)
X03YR02	957	26	14	85	24	109	(94, 148)
Notes							
fr is the number of species each represented by exactly r individuals in the sample.							
Observed richness = observed species richness.							
Undetected richness = estimated undetected species richness.							
Chao1 richness = Chao1 species richness estimator.							
95% conf. interval = the lower and upper confidence limits for the species richness at 0.95 level.							

Table 8. Cover-Line Intercept Data from FMH plots ANTI 1-8 to create species richness estimate using Good-Turing formula.

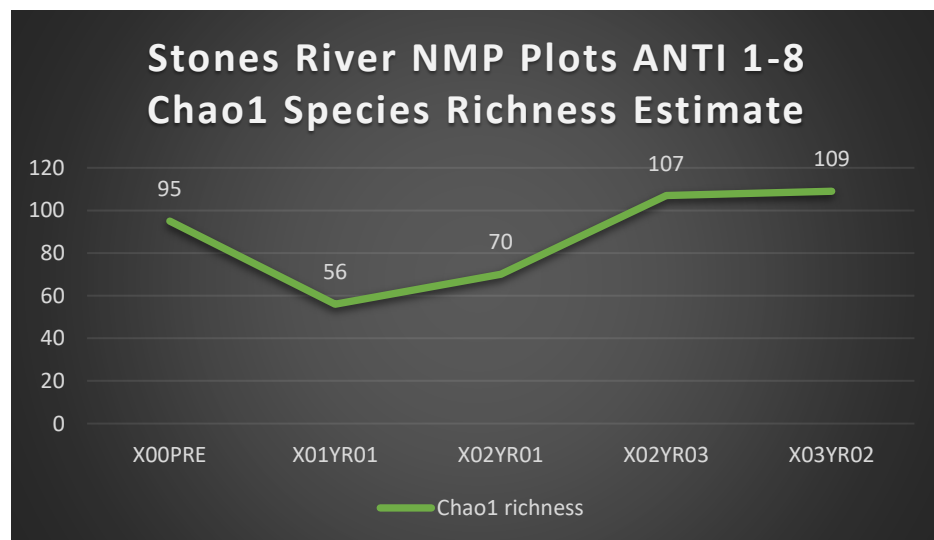


Figure 16: Chao1 Species Richness Estimate using Good-Turing formula

B. Program Information

Table 9. Planning - 2018

Park	Does Park have written Desired Future Conditions? (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/BAR plans in 2018?
Abraham Lincoln Birthplace NHP	No	N/A	0	0
Chickamauga and Chattanooga NMP	No	N/A	0	0
Cumberland Island National Seashore	No*	2014 (Draft)	0 (2) †	0
Fort Donelson National Battlefield	No*	N/A	0	0
Gulf Islands National Seashore	No*	2010 (Draft)	0 (3)	0
Horseshoe Bend National Military Park	No	N/A	0 (1)	0
Jean Lafitte NHP and Preserve	No	N/A	0	0
Little River Canyon National Preserve	No	N/A	0 (3)	0
Mammoth Cave National Park	No	2013 (Draft)	0 (6)	0
Natchez Trace Parkway	No	2007	0 (6)	0
Russell Cave National Monument	No	N/A	0 (1)	0
Shiloh National Military Park	No*	N/A	0 (1)	0
Stones River National Battlefield	No*	N/A	0 (3)	0
Vicksburg National Military Park	No*	N/A	0	0

Table 9

*Does not have written DFCs that have measurable objectives for park vegetation, but does have general desired landscape goals.

†Number in brackets represents number of Monitoring Type Descriptions (FMH 4).

Table 10. Monitoring - 2018

Park	% 2018 Data Entered	% 2018 Data Quality Checked	# Prescribed Fires Monitored*	# Non-fire Fuels Treatments Monitored*	# Wildfires Monitored *	# BAER/BAR Treatments Monitored*
Cumberland Island National Seashore	100%	100%	0	0	0	0
Gulf Islands National Seashore	100%	100%	2	0	0	0
Horseshoe Bend National Military Park	100%	100%	0	0	0	0
Little River Canyon National Preserve	100%	95%	2	0	0	0
Natchez Trace Parkway	100%	95%	2	1	0	0
Mammoth Cave National Park	100%	100%	0	0	0	0
Shiloh National Military Park	100%	100%	2	0	0	0
Stones River National Battlefield	100%	100%	2	0	0	0
Vicksburg National Military Park	100%	100%	0	0	0	0

Table 10

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

Table 11. Communicating Results - 2018

Park	# of Project Monitoring Reports completed in 2018	# of Annual meeting(s) with Park staff	# of Formal presentations of results	Do you use Minitab?*
Cumberland Island Nat. Seashore	0	1	0	No
Gulf Islands National Seashore	0	1	0	No
Horseshoe Bend NMP Park	0	2	0	No
Jean Lafitte NHP and Preserve	0	0	0	No
Little River Canyon National Pres.	0	3	0	No
Mammoth Cave National Park	0	0	0	No
Natchez Trace Parkway	0	3	0	No
Russell Cave National Monument	0	0	0	No
Shiloh National Military Park	0	1	0	No
Stones River National Battlefield	0	1	0	No
Vicksburg National Military Park	0	1	0	No

Table 11

* Minitab was not used for this year's analysis. It will be used for the following annual report.

Table 12. Research - 2018

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
Cumberland Island National Seashore	Yes	0	0		park-requested project with University of Florida; significant park-involvement
Gulf Islands National Seashore	Yes	0	0		
Horseshoe Bend National Military Park	No	0	0		
Jean Lafitte NHP and Preserve	Yes	0	0	Pre-burn floatant marsh monitoring has been established by Southern Illinois University ~2008	
Little River Canyon National Preserve	No	0	0		
Mammoth Cave National Park	Yes	0	1	Ongoing research concerning fire and Indiana bat habitat/LIDAR vegetation mapping by the University of Kentucky	
Natchez Trace Parkway	Yes	0	2	Blackbelt Prairie Restoration, Apios priceana reintroduction	
Shiloh National Military Park	No	0	0		
Stones River National Battlefield	No	0	0		
Vicksburg National Military Park	No	0	0		

Table 12

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

Table 13. Fire Ecologist 2018 Accomplishments/Focus Areas

Category	Percent Time	Accomplishments and/or areas of activities
<i>Data Collection</i>	<i>10%</i>	• <i>Redesigning and testing workflow and protocols for the program to better address revised objectives</i>
<i>Planning</i>	<i>20%</i>	• <i>Fire effect program planning, Mississippi River Zone planning</i> • <i>Reviewed LIRI, BISO, HOBE, GUIS, STRI burn plans.</i> • <i>Fire Effects program planning. MS River Zone planning (senior staff discussions),</i> • <i>Generate and maps and GIS compilation</i> • <i>Developed new photo and plot monitoring protocol</i>
<i>NPS Meetings/ task groups</i>	<i>10%</i>	• <i>Participated in Leadership Committee at NATR</i> • <i>In</i>
<i>Interagency work</i>	<i>5%</i>	• <i>Participated in Southern Pine Beetle SPB planning with USFS</i> • <i>Collaborated with Fish and Wildlife Service and Missouri Botanical Garden regarding reintroduction of Apios priceana into restored habitats</i>
<i>Wildfire Assignments</i>	<i>0%</i>	• <i>None to date</i>
<i>Prescribed fire projects</i>	<i>>5%</i>	• <i>FIRB and ENGB on multiple prescribed fires</i>
<i>Research</i>	<i><5%</i>	• <i>Contributed to proposals, reviewed proposals, met with researches to share information and collaborate..</i> • <i>Reviewed and shared ecological literature.</i> • <i>Correspondence with Universities</i>
<i>Data entry</i>	<i><2</i>	• <i>Monitors completed data entry, corrected data within FFI</i>
<i>Data analysis</i>	<i>10%</i>	• <i>Performed statistical tests and analysis of fire effects data for Zone Parks.</i> • <i>Summarized and shared fire effects data with Zone Parks when requested.</i> • <i>Work completed for 2018 Annual Report.</i>
<i>Supervision/Admin</i>	<i>10%</i>	• <i>Supervised lead monitor and 2 FTSF Fire Effects Monitors, completed performance evaluations, IDP's</i> • <i>Travel authorization/vouchers and time paperwork</i> • <i>Research and seek guidance on various scenarios</i>
<i>Miscellaneous</i>		

Table 13

D. Fire effects crew accomplishments and areas of focus

Table 14. Fire Effects Crew 2018 Accomplishments/Focus Areas

Category	Percent Time	Notes
<i>FMH plots</i>	5%	<i>Assisted with modifying protocols to standard FMH Plots</i>
<i>WUI plots</i>	0%	<i>No scheduled WUI plots for 2018</i>
<i>CBI plots</i>	5%	<i>Post burn monitoring on wildfire</i>
<i>Other plot work</i>	15%	<i>Rare Plant Monitoring, Trialing RAP Rapid Assessment Plots, and Survey123 data collection</i>
<i>Wildfire assignments</i>	5%	<i>Served in variety of roles including: FFT2, FFT1(T), FEMO, READ/REAF</i> <i>NATR wildfire incidents</i> <i>Wildfire assignments in California and Mississippi.</i>
<i>Prescribed fire projects</i>	15%	<i>Served in variety of roles including: FFT2, ATVO, FFT1, FEMO, Holding at NATR, LIRI, HOBE, BISO, SHIL and STRI</i> <i>Consultation for Rx burns</i> <i>Assist Forest Service on prescribed fires.</i>
<i>Non-fire fuels projects</i>	2%	<i>NATR Blackbelt Restoration, exotic, and hazard fuels removal projects</i> <i>Assisted with WUI vegetation clearing/saw work</i>
<i>Travel out-of-park for plot or project work</i>	5%	<i>Installed FMH plots at CUIS</i> <i>FMH monitoring at STRI, SHIL, MACA, GUIIS, LIRI, Tishomingo State Park</i>
<i>Data entry</i>	20%	<i>Copied, scanned, entered and checked FMH and other fire effects data , Re-organize plot photos to use with online and digital formats</i>
<i>Data analysis</i>	1%	<i>Fuels Analysis</i>
<i>Supervision/Admin</i>	10%	<i>Payroll, travel authorization/voucher, hiring etc.</i>
<i>Training</i>	5%	<i>Firefighter Refresher, READ Training, S-212</i>
<i>Miscellaneous</i>	5%	<i>Collected, identified, and preserved plant specimens for long-term data collection consistency and reference</i> <i>NATR Recycling Committee</i> <i>NATR Bio-blitz/Wildlife Weekend: Guided multiple walks for the public about birds and native flora. Staffed resource management booth.</i> <i>Organized and lead local Audubon Christmas Bird Count.</i>

Table 14. Fire Effects Crew Accomplishments/Focus Areas 2018

E. 2019 Direction

The Barrens to Bayous Fire Monitoring Network has undergone several changes and updates since its inception in 1999. The program began using the Fire Monitoring Handbook (FMH) Recommended Standard (RS) protocols and installed additional plots annually thereafter currently totaling over 200 across ten parks. There have been several different plot styles used and all are very useful, but full implementation reads often lack focus for answering specific questions and instead seek to collect enough data to cover as many future questions as possible. This is quite laudable: however given the scope of the zone it has exceeded our capacity to maintain such a workload.

We will transition to focus on specific questions pertaining to ecological change under a prescribed fire regime. Rather than thoroughly document the decline of our parks, we aim to provide answers to more pressing questions concerning the restoration of natural fire frequency and seasonality across our fire management zone. The survival of many native species of birds, plants, and animals dependent on fire maintained habitat is at stake. Fire ecology/effects will seek to identify any urgent needs for restoration otherwise there will be less to monitor in the future. Periodic surveys are needed to identify ecological refugia that may be uncovered with prescribed fire and may be of more importance than some previously sampled plots. For this reason, we will be using additional methods to monitor over a larger area.

We will begin implementing RAP's, Rapid Assessment Plots, to gain more coverage over the fire management areas and interpret change more readily to provide timely and actionable advice to prescribed fire professionals. These new plots will be circular with an 8 meter radius and take advantage of the features available to 360 degree spherical photographs. They are designed to take one hour or less to install and read with various optional protocols available to target specific objectives of each burn unit, park, or habitat. These will be used to augment, or in some cases replace, the long term FMH (Fire Monitoring Handbook) plots.

Many of the long term fire effects monitoring plots have been installed for over a decade and in some cases closer to two. The program has experienced low staffing for many years and a large majority of the plots are in need of rediscovery, maintenance, and repair. Past focus has been directed to reading plots rather than maintaining them. As such, plot maintenance has not been a priority for many sites which have corroded or missing rebar and tags. They are difficult to find due to the inaccuracy of GPS points, changed conditions to landscape references, tampering, or various other disturbances. We know of 30 plots out of 215 that have been completely lost or abandoned throughout the monitoring zone which accounts for 14% of all long term fire effects monitoring plots that are now lost. Our program will invest time and effort to stem further loss by (re) locating plots using GPS systems with sub-meter accuracy, update GIS records, reinstall necessary components, and maintain the plots to ensure longevity. This will likely occur during the dormant season, but will be opportunistic in nature. Ecology staff will prioritize

We need to address the public expectation that the money spent on fire management will deliver desired objectives, which necessitates having an ability to accurately forecast what will happen in the future (such as restoring degraded forest lands). Rather than fully maintain the previous

workload outlined in the Fire Monitoring Handbook, we will invest time working on priority needs and/or questions about our fire managed parks. Those needs and questions will be guided by natural resource park staff and further developed with input from all concerned stakeholders including the public. There is a wealth of scientific work to draw conclusions from in regards to our parks and management strategies. While there remains much unknown about natural ecological systems, efficiencies may be gained by relying on current scientific consensus as guidance to make predictions on what will happen by managing ecosystems with fire. We will also document ecological changes in a manner that provides a better understanding to the general public. To do this we will need to invest more fully in current technology by using modern digital methods of data collection and enhanced photography to better capture conditions and communicate our work.

The use of a terrestrial laser scanner is being revisited for monitoring fire effects by creating 3D scans of treatment areas. This will provide volumetric data of the forest over-story, mid-story, and under-story. Additionally, it will also quantify canopy cover and aboveground woody biomass which may become metrics within some newly revised objectives.

Data analysis methods are currently trialed and refined to further inform how to reach better efficiencies in collecting monitoring data. We will be trialing and comparing Chao1 and Chao2 Diversity Monitoring protocol to FFI cover values from point intercept to provide an alpha/beta diversity index or coefficient of variance for each plot, monitoring status, burn unit, or park. This may give better flexibility with monitoring since one of the revised objectives allows for monitoring either diversity or cover for herbaceous species. Several methods will be trialed including one that will utilize a species list specific to the area and will tally species present once, twice, and more than twice within a plot. Also being used is a newly applied estimator for undetected species richness and diversity using the Good-Turing formula, which was originally developed by Alan Turing during World War II to successfully crack the German Enigma code. Additionally, the software program SpadeR (Species-richness Prediction And Diversity Estimation in R) will be further explored to assist in refining monitoring protocols to be executed with the RAP's (Rapid Assessment Plots).

I would like to pay tribute to the memory of Jesse Burton, the former Mississippi River Zone Fire Ecologist. Jesse passed away in November 2018 from complications associated with brain cancer. To all who had the pleasure of knowing him, Jesse was much more than a creative and thoughtful ecologist. He will be remembered as a wonderful person who gave freely of his time, advice, and expertise. It is with great privilege that I continue to learn from his contributions and carry the torch of fire ecology.

F. Overall Data Entry Status and FFI suggestions

Program Data - We will soon have much data in need of migration. Recommend having a direct route from ESRI applications or well devised workflow to upload into database.

FFI Feedback – Consider cloud-based data management.

G. Optional Information

<https://chao.shinyapps.io/SpadeR/>

<https://chao.shinyapps.io/GoodTuring/>

DESCRIPTION OF ESTIMATORS/MODELS:

Homogeneous Model: This model assumes that all species have the same abundances or discovery probabilities. See Eq. (2.3) of Chao and Lee (1992) or Eq. (7a) of Chao and Chiu (2016b).

Homogeneous (MLE): An approximate maximum likelihood estimate under homogeneous model. See Eq. (1.1) and Eq. (1.2) of Chao and Lee (1992) or Eq. (3) of Chao and Chiu (2016b).

Chao1 (Chao, 1984): This approach uses the numbers of singletons and doubletons to estimate the number of undetected species because undetected species information is mostly concentrated on those low frequency counts; see Chao (1984), and Chao and Chiu (2012, 2016a,b).

Chao1-bc: A bias-corrected form for the Chao1 estimator; see Chao (2005) or Eq. (6b) of Chao and Chiu (2016b).

iChao1: An improved Chao1 estimator; see Chiu et al. (2014).

ACE (Abundance-based Coverage Estimator): A non-parametric estimator proposed by Chao and Lee (1992) and Chao, Ma and Yang (1993). The observed species are separated as rare and abundant groups; only data in the rare group is used to estimate the number of undetected species. The estimated CV of the species in rare group characterizes the degree of heterogeneity among species discovery probabilities. See Eq. (2.14) in Chao and Lee (1992) or Eq. (7b) of Chao and Chiu (2016b).

ACE-1: A modified ACE for highly-heterogeneous communities when CV of the entire dataset > 2 and species richness > 1000. See Eq. (2.15) in Chao and Lee (1992).

1st order jackknife: It uses the number of singletons to estimate the number of undetected species; see Burnham and Overton (1978).

2nd order jackknife: It uses the numbers of singletons and doubletons to estimate the number of undetected species; see Burnham and Overton (1978).

95% Confidence interval: A log-transformation is used for all estimators so that the lower bound of the resulting interval is at least the number of observed species. See Chao (1987).

Include any additional material not already covered in the sections above:

- Please email bob_boensch@nps.gov for access to ArcGIS StoryMap (to be published in July 2019) with maps of plots and links to 360 Spherical Photos of pre-burn and post-burn Parks.