

Southern Appalachian Fire Effects Team

Based currently out of Great Smoky Mountains National Park

Fire Ecology Annual Report Calendar Year 2004

Summary

Given the funding constraints that cut two seasonal and one permanent employee from the Southern Appalachian Fire Effects Team, and the late hire of our fourth permanent member, we accomplished an impressive amount.

Through the winter and spring we assisted the Fire Use Module with 8 prescribed burns in four parks (Mammoth Cave NP, Kings Mountain NMP, Congaree Swamp NP, and Great Smoky Mountains NP). These burns enabled us to work on FEMO and Squad Boss task books and assist the FUM in leadership positions. We completed 17 post-burn reads (14 forest plots and 3 grass plots) during this period.

During the summer and fall we completed 22 01yr01 reads and 5 01yr05 reads in three parks (Congaree Swamp NP, Kings Mountain NMP and Great Smoky Mountains NP). We initiated monitoring in two new parks: Cumberland Gap NHS (4 forest installs) and Big South Fork NRRRA (3 grass installs). We assisted researchers from Middle Tennessee University with a table mountain pine study and the Natchez Trace Fire Effects Team in monitoring at Mammoth Cave NP and Little River Canyon National Preserve. The lead and assistant lead helped the Zion Fire Effects Team re-read 16 brush plots and 1 ponderosa pine plot on the North Rim of the Grand Canyon and the assistant lead and crew member assisted the North Cascades Fire Effects Team for two weeks each.

The Fire Ecologist and Lead Monitor attended the Statistical Base for FEAT training in Colorado in May. The Fire Ecologist also attended the Bats and Forests Symposium and Workshop in Arkansas and a Fire Regime and Condition Class (FRCC) training in Maryland. The entire crew helped teach the monitoring section of Rx-310 (Introduction to Fire Effects) in Black Mountain, NC in November.

The Fire Ecologist and Lead Monitor began analyzing the Smokies seven years of data and put together presentations for three conferences: Ecological Society of America (ESA), Southern Appalachian Man and the Biosphere (SAMAB), and All Taxa Biodiversity Inventory (ATBI).

Table 1. Fire Effects Plot Workload 2004

Park	Monitoring Unit	Type of Plot (FMH, photo point, other)	Pre-burn	Immed. Post	Postburn (1-20 yrs)	Total Plots
Big South Fork	Little Bluestem	FMH grass plot	3			3
Congaree Swamp	Longleaf Pine	FMH Forest plot		6	6	12
Cumberland Gap	Scarlet Oak	FMH Forest plot	3			3
	Virginia Pine	FMH Forest plot	1			1
Great Smoky Mountains	Pitch Pine	FMH Forest plot			5	5
	Scarlet Oak	FMH Forest plot	1	4	5	10
	Black Oak	FMH Forest plot			3 (2C)	5
	Table Mt Pine	FMH Forest plot	1			1
Kings Mountain	Chestnut Oak	FMH Forest plot		5	5	10
	Blackjack Oak	FMH Forest plot		1	1	2
Mammoth Cave*	Eastern Red Cedar	FMH Forest plot		4		4
	Little Bluestem	FMH grass plot		3		3
Total			9	23	27	59

*Natchez Trace Fire Effects crew is now fully in charge of monitoring at Mammoth Cave. They were, however, unable to attend several burns and as we were there, we completed the post burn reads.

Table 2. Fire Ecology Staffing 2004

Monitor	Starting Date	Ending Date	# of Pay Periods	Training and Development
Rob Klein	1/1/04	12/31/04	26	FEAT training; co-author for ESA, SAMAB, and ATBI Conference presentations; FRCC training
Virginia McDaniel	1/1/04	12/31/04	26	FEAT training; presented as co-author at ESA, SAMAB and ATBI Conferences; Taught monitoring at Rx-310
Nunally Benzing	3/8/04	12/31/04	21	Taught monitoring at Rx-310
Wylie Paxton	6/28/04	11/11/04	10	Rx-310; Taught monitoring at Rx-310
Jeanne Boland (SCA)	6/14/04	8/26/04	5.5	
Troy Evans (SCA)	4/6/03	12/31/03	6	Taught monitoring at Rx-310

Table 3. Management Objectives and Monitoring Results 2003

A. Great Smoky Mountains National Park (TN/NC)

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (80% confidence interval)	Objective Achieved?
FPIRI1D08 – Pine Woodland	Minimum 25% reduction of duff loading after 1 burn	Duff loading reduction = 29-(39)-50% (<i>n=17 plots, 5 fires</i>)	YES
	Minimum 50% reduction in pole density after 1 burn	Pole density reduction = 50-(64)-79% (<i>n=17 plots, 5 fires</i>)	YES
FQUCO1D08 Oak Forest	Minimum 20% reduction of duff loading after 1 burn	Duff loading reduction = 2-(14)-25% (<i>n=5 plots, 2 fires</i>)	NO
	Minimum 40% reduction in pole density after 1 burn	Pole density reduction = 3-(6)-10% (<i>n=5 plots, 2 fires</i>)	NO

B. Kings Mountain National Military Park (SC)

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (80% confidence interval)	Objective Achieved?
FQUMO1D09 Chestnut Oak Forest	Minimum 20% reduction of total fuel loading after 1 burn	Total fuel load reduction = 16-(23)-30% (<i>n=19 plots, 7 fires</i>)	NO*
	Minimum 30% reduction in pole density after 1 burn	Pole density reduction = 22-(34)-46% (<i>n=19 plots, 7 fires</i>)	NO*
FQUMA1D09 Blackjack Oak Woodland	Minimum 20% reduction of total fuel loading after 1 burn	Total fuel load reduction = 6-(29)-50% (<i>n=3 plots, 2 fires</i>)	NO*
	Minimum 30% reduction in pole density after 1 burn	Pole density reduction = 4-(20)-37% (<i>n=3 plots, 2 fires</i>)	NO

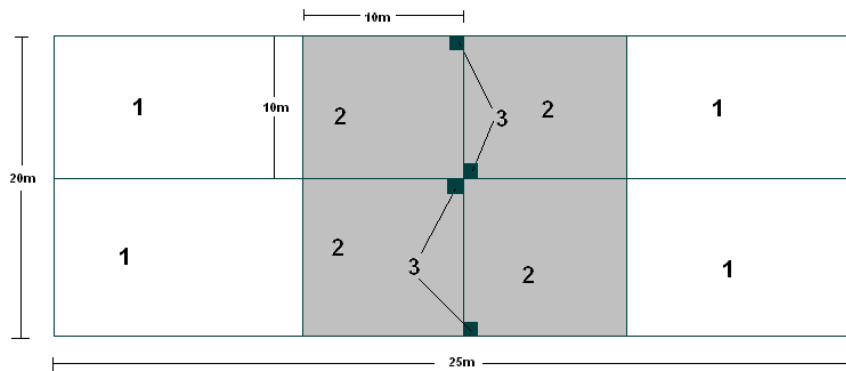
* Indicates that the mean value (in parentheses) for the result suggests that the objective was achieved.

Discussion of Results

Results are only presented for two of the parks where we currently have monitoring plots established. The other park where we have post-burn data (Congaree Swamp) has too few plots at this time to warrant any serious analysis. It should also be noted that the results shown in these tables very short term in nature and several of the results have a very small sample size. The prescribed fire programs at GRSM and KIMO are still young, and solid short and long term resource objectives have not been fully established. In addition, because of the youth of these programs, very little of our data go beyond the 01yr2 status. Thus, the objectives given above are provided as “best guesses” of how existing long term resource goals may be used to develop short term quantifiable objectives. By creating such objectives for a single burn, we are able to begin looking at the variability in some of our key variables. In short, these objectives are placeholders, and a true assessment of whether these programs are achieving objectives cannot be made at this time. This is a start.

Sampling Design & Field Methods

In addition to normal FHM protocols, we use a nested subplot to obtain information on the scale of occurrence of species in the plot. It also provides a species list for each plot. We feel this method is more accurate than the five meter observation along side the herbaceous transect which is very difficult, if not impossible, to accomplish accurately in the thick vegetation many of our plots are located. We normally collect this data in each of the 4 quadrants at three scales (3 = 1 m², 2 = 100 m² and 1 = 250 m²).



Nested Subplot Design as of 2002

Status of Planning Documents

The status of planning documents for the parks is generally good. All of the parks where we currently have monitoring established have recently completed and approved Fire Management Plans. The 5-year prescribed burn schedules are not as accurate as would be hoped, but that seems to be the rule, not the exception, in NPS programs. Our program has consistently lagged behind in producing Fire Effects Monitoring Plans, though we are currently working on such plans for three of our parks with the longest running monitoring programs. We hope to have completed by late 2005 monitoring plans for Great Smoky Mountains National Park, King's Mountain NMP, and Congaree National Park. During winter '05/06, we should be able to complete plans for Big South Fork NRR and Cumberland Gap NHP.

Additional Monitoring Results

Introduction

This year we asked many questions of our data. Some questions were answered clearly, while others will require more data. In order to analyze the data with more analyses than FMH software allowed, we converted some (tree and pole data) to MS excel.

In Great Smoky Mountains National Park, the yellow pine monitoring type has the most burned plots. In preburn monitoring of these plots we noticed an encroachment of fire-intolerant woody stems and a paucity of yellow pine in the seedling or sapling size classes. In some areas the southern pine beetle had taken a toll on the over-story. Our overarching question is: How do we restore these communities to their historic structure and composition? We know fires historically burned through these ecosystems every 7-12 years. Reintroducing fire would be our means of restoration, but what kind of fire and under what conditions?

Let's take it back a step. We know we need pine seedlings or the yellow pine community will be lost. We know pine seedlings require a thin duff layer to germinate and a lot of light to thrive. So our three questions become:

1. What tree mortality is necessary to promote pine seedling germination?
2. What is the duff reduction necessary to promote pine seedling germination?
3. What is the optimal fire severity?

Methods

Between 1997 and 2003 we burned 5 burn units in the western portion of Great Smoky Mountains National Park (Figure 1). We installed 19 plots in these burn units before the burn and

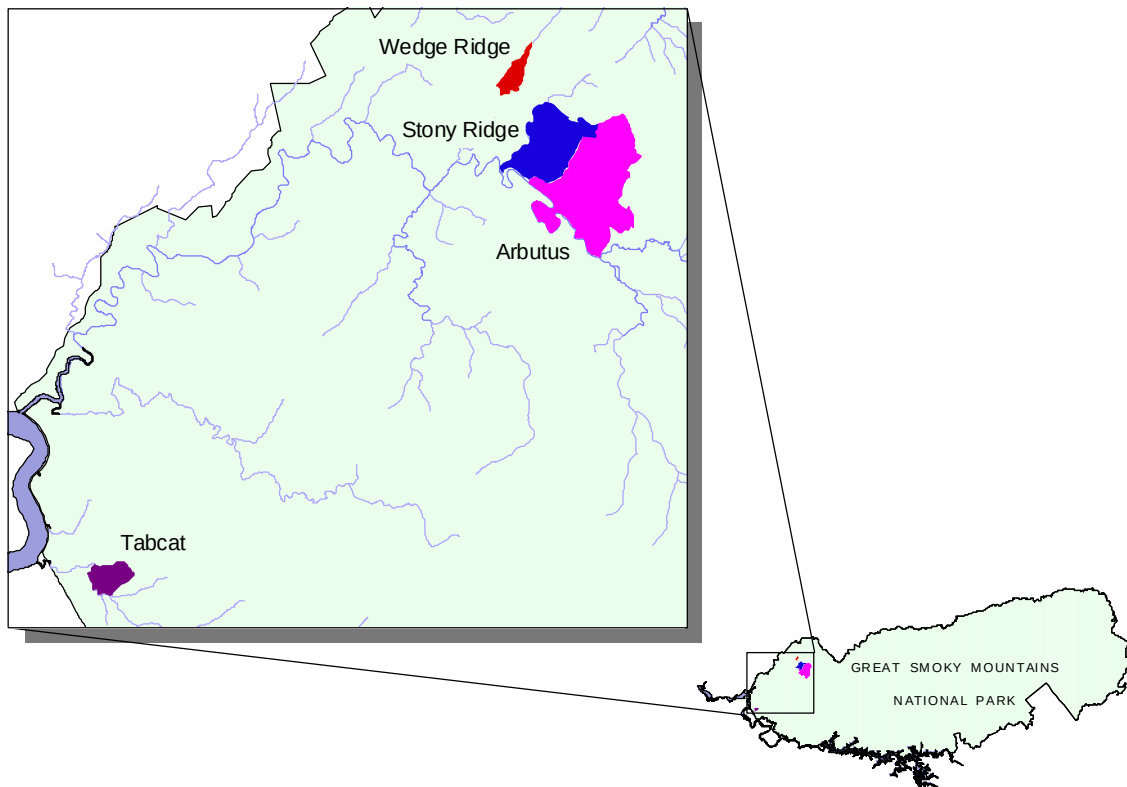


Figure 1. Locations of five burn units in Great Smoky Mountains National Park. Note that Tabcat appears to be only one burn unit, but is really two.

monitored them before and one year after the burn. While we have more data than one year for some plots, we chose to look at year-one data to keep 19 plots in the analysis.

Standard FMH (Fire Management Handbook) protocols were used to collect the data with over-story tree (>15.1 cm DBH) data collected in a 0.1 ha plot, pole-sized trees (2.5-15.1 cm DBH) data collected in a 250 m² area and seedlings (<2.5 cm DBH) data collected in a 50 m² area. For statistical analyses we used t-tests, regressions and non-linear regressions (SigmaStat and Excel).

Results

Between pre-burn and one-year post-burn we found a 70% ($p=0.03$) reduction in pole-sized trees from about 1600 stems/ha to 650 stems/ha (Figure 2). When we looked at the relationship between tree mortality and pine seedling density we found a positive exponential curve was the best fit (Figure 3). Interestingly, we noticed a threshold mortality at 85%. Before that point, pine seedling density was very low, but after that point pine seedling density increased exponentially.

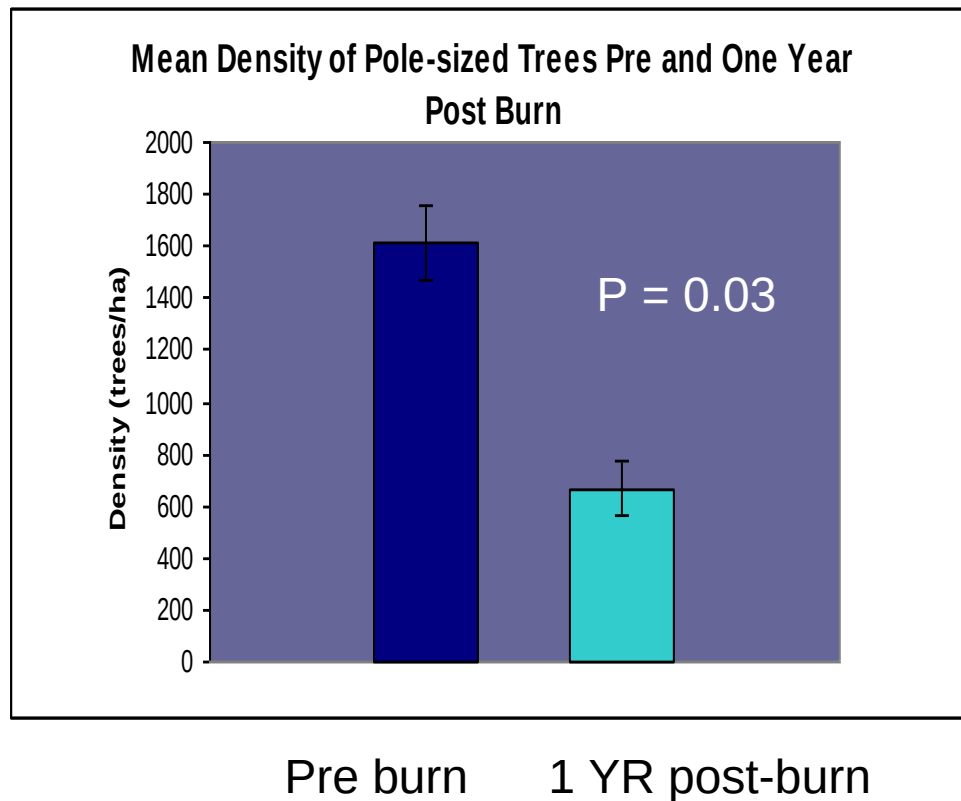


Figure 2: Reduction in pole-sized trees from pre-burn to one-year post-burn.

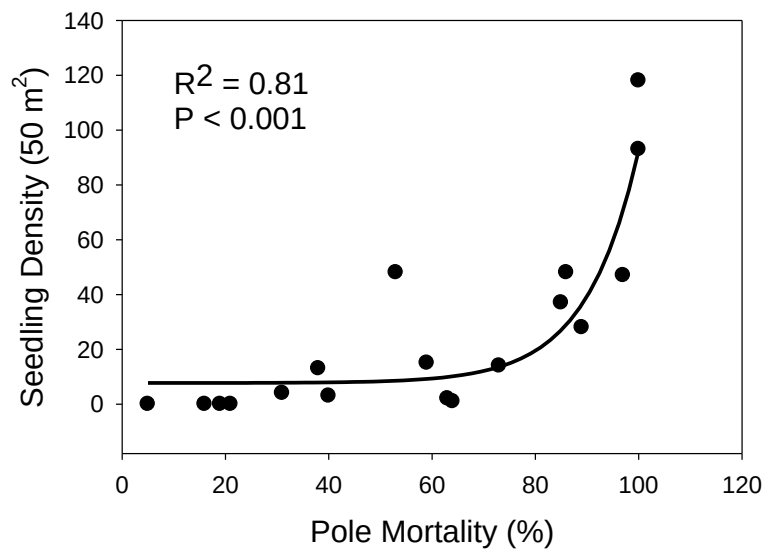


Figure 3: Relationship between pine seedling density and pole-sized tree mortality.

Between pre-burn and one-year post burn we found duff was reduced from about 7 cm to 5 cm ($p < 0.001$, Figure 4). When looked at the relationship between pine seedling density and duff depth we found a negative exponential function to be the best fit line (Figure 5). Once again we noticed a threshold value; this time at 3 centimeters. With more than 3 centimeters of duff, we find very few pine seedlings, but once duff is below 3 centimeters pine seedling density increases exponentially.

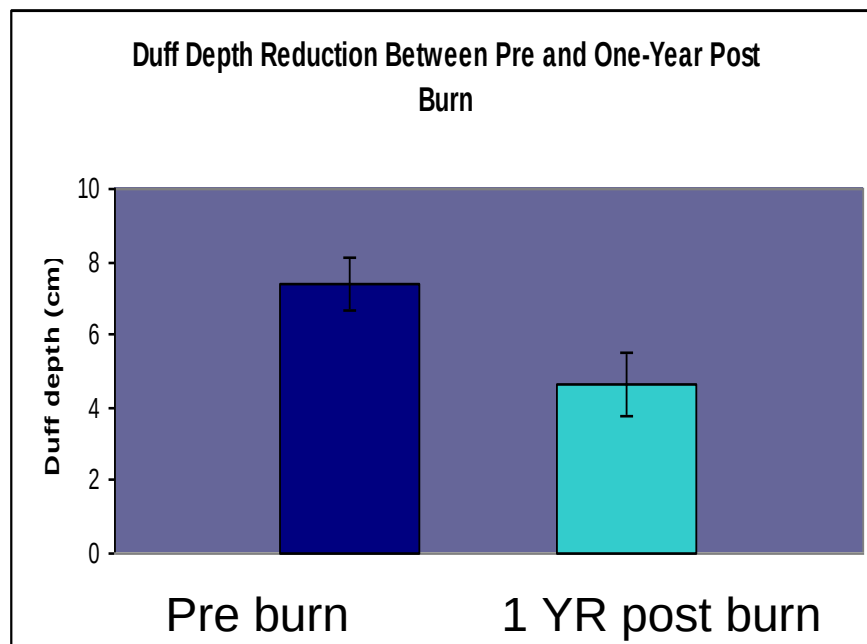


Figure 4: Reduction in duff from pre-burn to one-year post-burn.

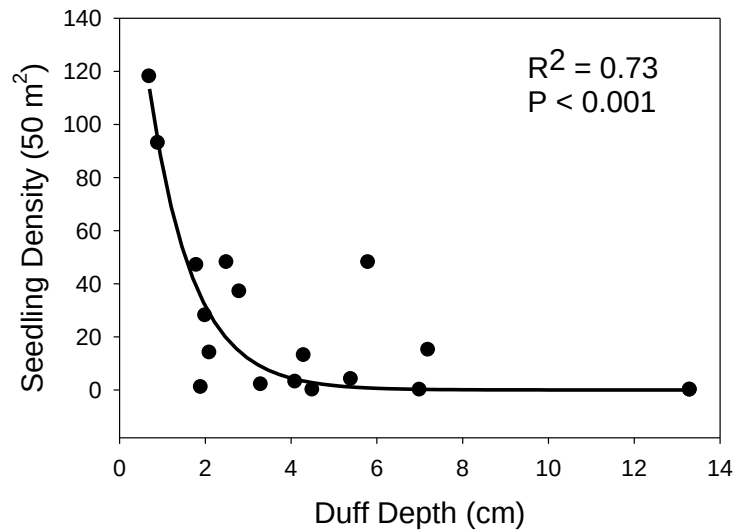


Figure 5: Relationship between seedling density and duff depth one-year post-burn.

Next we decided to group the plots by burn unit. In both the seedling density vs. pole mortality (Figure 6) and seedling density vs. duff depth (Figure 7), the burn units seemed to cluster together: Arbutus with the lowest mortality and highest duff depths, Stony Ridge and Tabcat B in the middle and Tabcat A and Wedge Ridge with the highest mortality and lowest duff depths. When we looked at duff percent reduction (Figure 8) Tabcat A and Wedge Ridge reduced duff by over 70% while Arbutus, Stony Ridge and Tabcat B reduced duff by less than 20%.

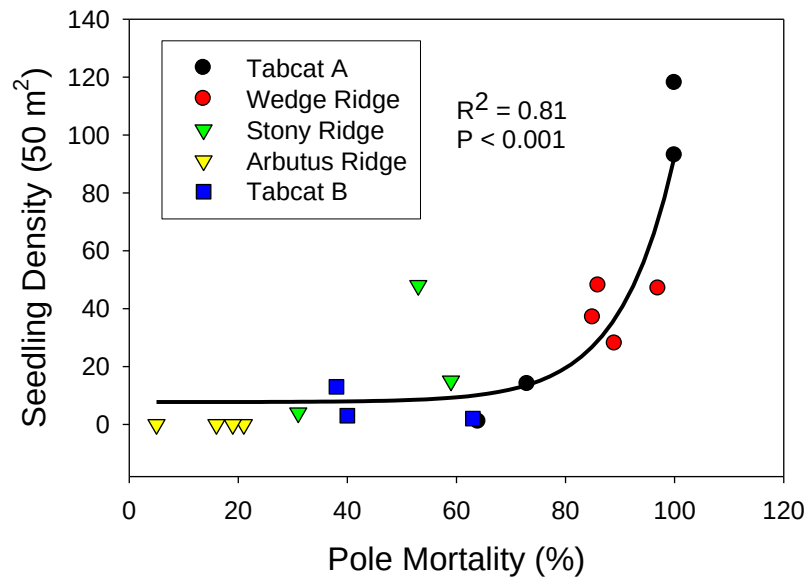


Figure 6: Relationship between pine seedling density and pole mortality grouped by burn unit.

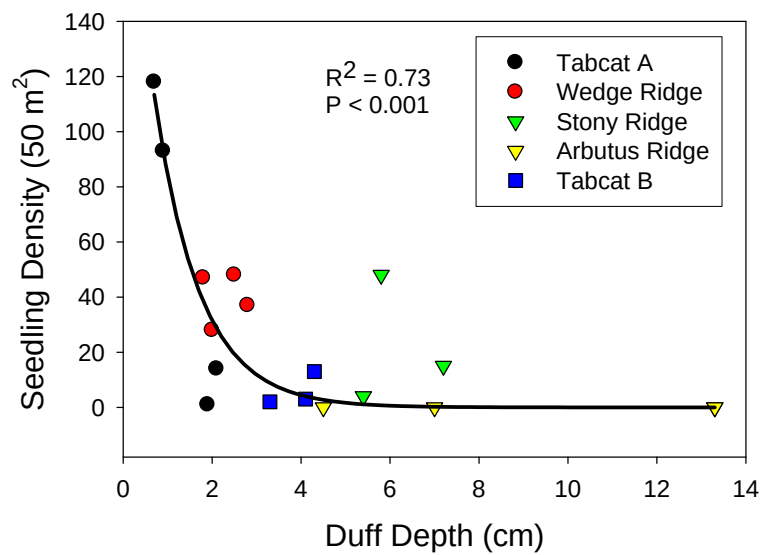


Figure 7: Relationship between pine seedling density and duff depth grouped by burn unit.

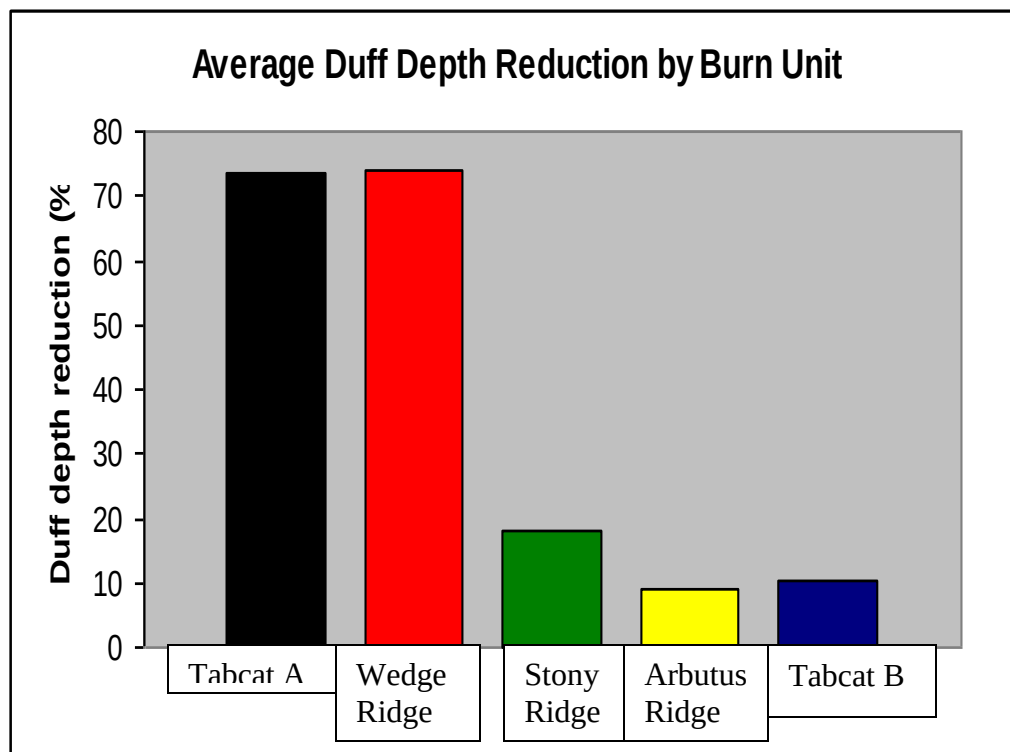


Figure 8: Percent duff reduction by burn unit.

Discussion

Our data show that fires that kill more trees and consume more duff have more pine regeneration. What made the Tabcat A and Wedge Ridge fires more severe than Arbutus Ridge, Stony Ridge and Tabcat B? In the previous annual report we speculated on duff moisture, ignition technique, time of year burn occurred. This year we have some of the answers. The two hot burns occurred in the fall. The three cooler burns occurred in the spring. Perhaps the fall burns prepared the seedbed for the pines which drop their seeds in the spring, while spring burns burned the seeds and gave the hardwoods an entire season to pre-empt light and nutrients. Second, is it drier in the fall? Looking at a KBDI graph from 1997 to 2003 (Figure 9) the answer appears to be yes. The highest KBDI values for the longest duration consistently occur in the fall. The average KBDI for the hot burns was 348, while for the cool burns it was 43. If we look at a regression of KBDI to duff consumed we see a highly significant, positive, predictable relationship (Figure 10).

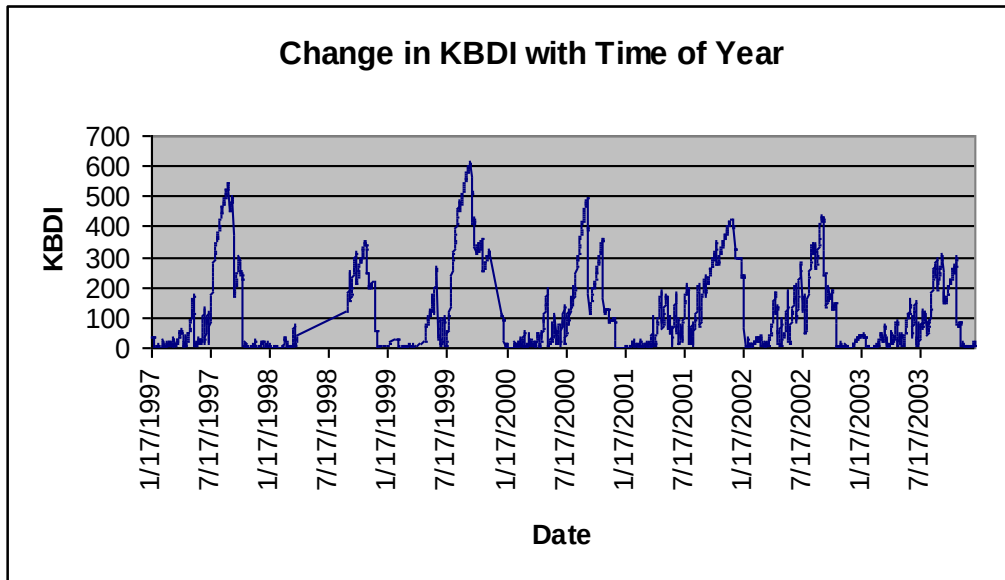


Figure 9: Keech Byrum Drought Index values between 1997 and 2003 near Great Smoky Mountains National Park.

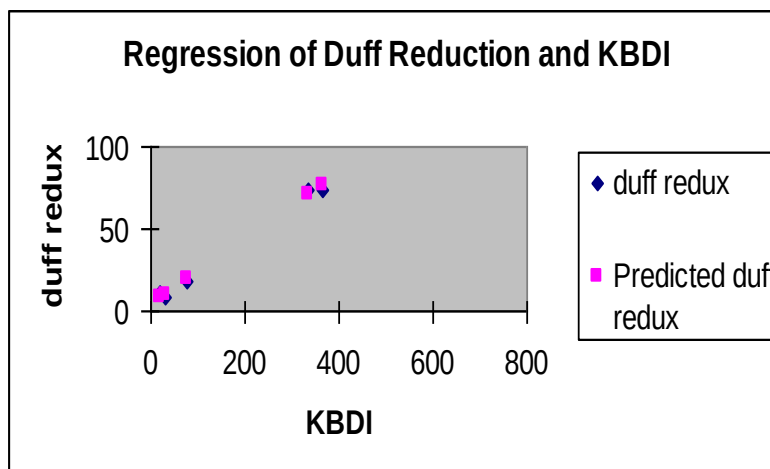


Figure 10: Regression of duff reduction and KBDI for fire prescribed burns at Great Smoky Mountains National Park.

Research Projects/Collaboration

We are collaborating with Dr. Nicole Turrill Welch and her graduate student, Dwayne Coleman, from Middle Tennessee University who are studying the relationship between soil characteristics and table mountain pine (TMP) regeneration. We collected data with them at the Green Mountain Fire (a 3-year-old TMP stand) and Bote Mountain (a 15 year-old TMP stand).

Adaptive Management

In the past year, the GRSM fire effects/fire ecology program began an effort to provide update-reports to resource and fire managers at each of the parks where we have established monitoring programs. We have already completed extended analyses for Great Smokey Mountains NP and King's Mountain NMP and presented results to park managers and/or to the larger regional resource community. With these fire programs still essentially in their infancy, these results will be critical in shaping "new and improved" resource objectives. Additionally, fire effects results have been reported and discussed in meetings with regional Fire Use Modules, which are responsible for much of the fire planning and implementation within the region. These meetings have created a very constructive dialogue that seeks to inform prescribed fire implementation techniques with actual fire effects results, a collaborative approach that has often not been the norm.

Publications and Presentations

List scientific and educational publications produced (include full citation).

McDaniel, V.L. 2004. Burning for Biodiversity. ATBI Quarterly. Spring 2004.

McDaniel, V.L. and R.N. Klein. 2004. Post-fire regeneration of yellow pine (*Pinus echinata*, *P. rigida*, and *P. virginiana*) communities in Great Smoky Mountains National Park, TN. Abstract in proceeding for the Ecological Society of America 89th Annual Meeting, Portland, OR, August 1-6, 2004.

McDaniel, V.L. and R.N. Klein. 2004. Post-fire regeneration of yellow pine (*Pinus echinata*, *P. rigida*, and *P. virginiana*) communities in Great Smoky Mountains National Park. Abstract in proceedings of the 15th Annual SAMAB Conference, Gatlinburg, TN, November 16-18, 2004.

McDaniel, V.L. and R.N. Klein. 2004. Burning for Biodiversity. All Taxa Biodiversity Inventory Conference, Gatlinburg, TN, December 7-10, 2004.