



**National Park Service
Ozark Highlands Cluster
Fire Ecology Annual Report
Calendar Year 2008**

Summary

2008 was a very successful year for the Ozark Highlands fire ecology program. This year the monitoring crew consisted of four seasonal biological science techs and an SCA intern. Everyone did an excellent job and was critical to our program's accomplishing all of our fire effects plot work. The lead monitor and winter seasonal read 3 immediate postburn plots in Hot Springs while the fire effects monitoring crew reread 57 FMH plots at Ozark NSR, Buffalo NR, Pea Ridge NMP, and Hot Springs NP. In addition, 24 modified plots were installed and read at Buffalo NR and Hot Springs National Park. Unfortunately, the spring fire season's weather did not cooperate in Missouri or Arkansas. Due to an extremely wet spring, only one prescribed burn was accomplished at BUFF and no attempts were made otherwise. Erin did go on one wildfire assignment during last summer's busy fire season. Erin worked on the East Slide Rock Ridge fire in Nevada as a field observer (T) in August through September. In addition, the entire fire effects crew assisted as national resources on fires. Audrey Beres and Tray Hall assisted on the Iron Complex as an FFT2 and FFT1 (T). Charles Aldridge and Jesse Goodwin assisted as FFT2s in Northern California, and Janice Ralls as an FFT2 in Oregon. In August, Dan Swanson moved to the Black Hills of SD to be the Northern Great Plains fire ecologist. He had been the fire ecologist for the Ozark Highlands for four years.

We continued working in a new database called FFI (FEAT/Firemon/Integrated). Our data from the previous software, FEAT, was converted into the new format late winter and all of the 2008 field data was entered into the new software and data-checked.

Table 1. Fire Effects Plot Workload 2008

Park	Monitoring Unit	Type of Plot (FMH, photo point, other)	Pre-burn	Immed. Post	Postburn (1-20 yrs)	Total Plots within Mon. Type
Ozark NSR	Glade/Woodland Transition	FMH forest plot	0	0	10	20
Ozark NSR	Dry Mesic Woodland Oak/Hickory	FMH forest plot	0	0	7	14
Ozark NSR	Dry Woodland Oak/Hickory/Pine	FMH forest plot	0	0	10	19
Ozark NSR	Various	Fuels	24	0	0	61
Ozark NSR	Various	CBI	0	0	0	101
Buffalo NR	Glade/Woodland Transition	FMH Forest plot	0	0	8	10
Buffalo NR	Dry Woodland Oak/Hickory/Pine	FMH Forest plot	0	0	7	17
Buffalo NR	Open Fields	FMH Grass plot	0	0	2	2
Buffalo NR	Dry Woodland Oak/Hickory/Pine	Modified Forest plot	16	0	0	16
Pea Ridge NMP	Oak Hickory forest/Woodland	FMH Forest plot	0	0	3	6
Pea Ridge NMP	Post Oak – Black Jack Oak Woodland	FMH Forest plot	0	0	5	6
Pea Ridge NMP	Restored Prairie/Fields/Glades	FMH Grass plot	0	0	0	2
Hot Springs NP	Dry Woodland Pine-oak	FMH Forest plot	0	3	5	7
Hot Springs NP	Wildland-urban interface	Mechanical thinning plot	0	0	0	4
Hot Springs NP	Dry Woodland Pine-oak	Modified Forest plot	8	0	0	8
Total			48	3	57	293

Table 2. Fire Ecology Staffing 2008

Monitor	Starting Date	Ending Date	# of Pay Periods	Training and Development	Fire Assignments
Dan Swanson Fire Ecologist	NA	Permanent, full time	16	Botany, FFI, Yellowstone '88 Fires Conference	
Erin Yeoman, Lead Monitor	1/6/08	10/27/07	25	Botany, FFI, Rx510, S-271, S-330	E. Slide Rock Ridge, NV, 17 days
Audrey Beres, Asst. Lead monitor	5/11/08	10/25/08	12	Botany, S-290, S-131	Iron Complex, CA, 18 days
Charles Aldridge, monitor	5/11/08	8/15/08	7	Botany, S-290, S-131	Cal 08 Prep, CA, 18 days
Tray Hall, monitor	5/11/08	9/27/08	10	Botany, S-290, S-131	Iron Complex, CA, 18 days
Janice Ralls, monitor	5/11/08	10/25/08	12	Botany, S-290, S-131	Various fires, OR, 11 days
Jesse Goodwin, SCA monitor	5/11/08	8/15/08	7	Botany, S-290, S-131	Cal 08 Prep, CA, 18 days

Table 3. Management Objectives and Monitoring Results 2007

Park	Monitoring Unit	Management Objective	Monitor- ing Results	Objective Achieved
Ozark National Scenic Riverways	Glade/Transition	Reduce the density of pole trees (2.5-15 cm dbh) by at least 40% within two growing seasons after 2 nd burn ; (80% C.I.)	29% Decrease	No n=13, 2 fires
		Increase the average number of species (per quadrat) in the herbaceous layer by at least 40% within two growing seasons after the second burn (90% C.I.)	29% Increase	No n=13, 2 fires
	Dry-Mesic Woodland (Oak/Hickory/Pine)	Reduce the density of pole trees (2.5-15 cm dbh) by at least 30% within two growing seasons after 2 nd burn; (80% C.I.)	49% Decrease	Yes n=9, 2 fires
		Increase the average number of species (per quadrat) in the herbaceous layer by at least 20% within two growing seasons after the second burn (90% C.I.)	15% Increase	No n=9, 2 fires
	Dry Woodland (Oak/Hickory/Pine)	Reduce the density of pole trees (2.5-15 cm dbh) by at least 30% within two growing seasons after 2 nd burn; (80% C.I.)	52% Decrease	Yes n=11, 2 fires
		Increase the average number of species (per quadrat) in the herbaceous layer by at least 40% within two growing seasons after the second burn (90% C.I.)	19% Increase	No n=11, 2 fires
Buffalo National River	Glade/Transition	Increase the average number of native species in the herbaceous layer by at least 40% within two growing seasons after the second burn; (90% C.I.)	No Change	NA n=6, 2 fires
		Reduce pole density (2.5 – 15 cm dbh) by 60% after 10 years of burning; (80% C.I.)	12% Decrease ¹	NA n=6, 2 fires
		Reduce new growth eastern red cedar by 95% after three consecutive burns (90% C.I.)	34% Decrease ¹	NA n=6, 2 fires
	Dry Woodland	Reduce tree density to open vista with a target density of 74 trees/hectare after 20 years (80% C.I.)	300 tph ¹	NA n=7, 2 fires
		Reduce pole density (2.5-15 cm dbh) by 60% after 10 years of burning; (80% C.I.)	57% Decrease ¹	NA n=7, 2 fires

		Reduce live stems/acre by 60 % over 10 years of burning (90% C.I.) ¹ Two seasons after 2 nd burn treatment	46% Decrease ¹	NA n=7, 2 fires
	Open Fields/Cane Communities	Open fields - Maintain/restore/introduce native grass species and increase percent cover of native species by 25% after three prescribed burn applications (80% C.I.) Cultural/historic - Maintain historical farmstead openings, establish monitoring photopoints, maintain woody species density at 90% of preburn level within open fields over 10 years of burning (80% C.I.) Cane communities - maintain or increase size of cane community after 10 years of burning (90% C.I.)	NA	NA
Pea Ridge National Military Park	E. Red Cedar/Mixed Hardwood/Old Fields/Disturbed Sites	Reduce mean density of pole-sized trees (2.5-15cm dbh) by 30-40% after four burns; (80% C.I.) Increase mean density of oak seedlings and/or resprouts by 300-500% after four burns; (80% C.I.) Increase mean percent cover of native herbaceous species by 50-70% after four burns. (80% C.I.)	NA	NA
	Oak Hickory Forest/Woodland	Reduce mean density of pole-sized trees (2.5-15cm dbh) by 50-70% after four burns; (80% C.I.) Increase mean density of oak seedlings and/or resprouts by 300-500% after four burns. (80% C.I.)	18% Decrease 24% Increase	NA n=3, 1 fire NA n=3, 1 fire
	Post oak-blackjack oak savannah/woodland	Reduce mean density of pole-sized trees (2.5-15cm dbh) by 50-70% after four burns; (80% C.I.) Increase mean percent cover of native herbaceous species by 60-100% after four burns (80% C.I.)	6% Decrease	NA n=5, 1 fire NA n=5, 1 fire
	Restored Prairies/Fields/Glades	Reduce mean percent cover of live trees, shrubs, and woody vines by 75-85% after four burns; (80% C.I.) Reduce the mean percent cover of non-native species by 30-40% after four burns (80% C.I.)	NA	NA

Fire ecologist accomplishments and areas of focus

Accomplishments include time worked as the Ozark Highlands park ecologist (1/1/08 – 8/3/08) and Northern Great Plains park ecologist (8/4/08 – present). While Dan was working as the ecologist for the Ozark Highlands network parks, he collaborated with the fire education specialist and I&M Heartland Ecologist on a natural resource report on the Ozark National Scenic Riverways. This report documented the effects of prescribed burning on each of the park's monitoring types. After Dan's arrival to the Black Hills in mid August he began working on a ten year program review that Cody Wienk had initiated more than a year earlier. Analysis was done by monitoring type at the burn unit level and park. This thorough analysis has helped our program determine whether monitoring objectives need to be modified and/or eliminated. Drought appears to be a much stronger driver in vegetation structure/composition than does fire in our native mixed grass and non-native prairie ecosystems. Many of our vegetative cover monitoring objectives were not met probably due to the severe drought that affected the area from 2001-2007. We have seen herbaceous cover decline during periods that coincide with drought, irrespective of whether prescribed burns have occurred the previous years. Meetings with the Northern Great Plains Inventory & Monitoring program continued this fall and winter to determine whether we could combine our work effort to the benefit of both programs. In 2009 the I&M program will install 310 intensive plots throughout their network. The following year the fire effects program will help I&M read monitoring plots for the North Dakota parks to assess changes at the park level, and I&M will help the fire ecology program install/read a greater number of forest and fuels plots in the Black Hills parks. The two programs plan on using the same sampling designs with randomly, spatially distributed plot locations so that vegetation changes across the landscape can be assessed in relation to fire and precipitation patterns. The

fire ecology program in the past has not had any control plots due to time constraints and this has inhibited our ability to ascertain the driver of changes in the herbaceous layer.

Dan also spent a significant amount of time dealing with and resolving issues relating to the FEAT to FFI conversion. Many of the issues related to data that was collected in non-FMH protocols but were resolved after working with the FFI programmer. Reorganization of the plot naming convention was also implemented this fall to accommodate the various plot designs and protocols.

In September Dan went to Rocky Mountain N.P. to assist with the Estes Park prescribed burn which ended up being their largest in history. He also participated on the Campground and Hilltop prescribed burns at Wind Cave and Jewel Cave this fall as the fire effects monitor.

Table 4. Fire Ecologist Accomplishments/Focus Areas

Category	Percent Time	Accomplishments and/or areas of activities
Planning	10%	Determining fire effects plot / CBI location and establishment in monitoring types at OZAR, BUFF, PERI, and HOSP. Determining fire effects travel costs to area parks. Training of field crew in FFI and CBI protocols
Presentations	5%	Park staff, public meetings, and training; Arbor Day presentation to elementary school
NPS Meetings/ task groups	10%	Park meetings, I&M meetings, GMP meetings, OZAR safety committee meetings
Interagency work	1%	
Fire Assignments	4%	FEMO on 4 RX fires (4 operational periods), FFT2 on 2 RX fires (4 operational periods), FFT2 on 1 WF(1 operational periods)
Research	3%	Assisted Fire Education specialist with glade monitoring project
Data entry	1%	Estimated amount of time spent entering data from paper to PC
Data Conversion	12%	FEAT to FFI conversion issues
Data management & analysis	32%	Northern Great Plains and Ozark Highlands area parks fire effects data analysis
Supervision/Admin	15%	Hiring, supervision, travel, payroll, etc
Training	2%	FFI Workshop, Botany training, fire refresher
Miscellaneous	5%	NGP fire management web site, Writing burn reports, collaborated in writing a natural resource report on the Ozark National Scenic Riverways

Table 5 Fire effects crew accomplishments and area of focus

Category	Percent Time	Notes
FMH plots	65%	Time spent collecting plot data; including preparation time.
Modified plots	10%	
Other plot work	2%	Live/dead fuel moisture monitoring
Fire Assignments	6%	Lead was on 1 RX fires and 4 WF. Seasonals on 5 WF
Fuels Project work	0%	Fuels project work
Data entry	12%	100% of 2008 fire effects data entered and checked by Oct. 24
Data Mgmt conversion	5%	Preparing species lists and error checking
Report	5%	
Supervision/Admin	4%	Travel, payroll, etc
Training	8%	Lead-Botany, Rx 510, S-217, FFI,S-330,Temps-Botany, S-290, S-131

Additional Items from 2008

1. Identify types of fire effects monitoring databases or spreadsheets being used (e.g., FFI, Access, Excel).
 - FFI, Excel
2. **Annual Meetings** - Provide a brief description of the 2008 meeting(s) where fire ecologists present and discuss monitoring results with fire and non-fire park staff, and others have informal discussions.
 - A presentation covering the last ten years of fire effects data collection was given to the Northern Great Plains Technical Committee in early December. The presentation lasted over an hour and analysis was shown documenting whether fire effects monitoring objectives were being met for each monitoring type at the park level.
 - I gave a presentation to the Buffalo NR fire management officer, prescribed fire specialist, and natural resource staff in June on how effective the Ozark Highlands fire effects program is meeting their objectives at Pea Ridge N.M.P., Hot Springs N.P., and Buffalo N.R. I also presented new methods and protocols in project level monitoring that would be used in proposed burn units.

Ozark National Scenic Riverways

Glade / Woodland Transition Monitoring Type

I looked at relative change in overstory and pole density as well as species richness after two prescribed burns. Absolute change in herbaceous plant cover was also analyzed following two burns.

Effect of Prescribed Fire on Overstory and Pole Tree Density

There is an 80% certainty that there is at least a 29% decrease in pole trees pre-burn to second growing season after the second prescribed burn (Figure 1). Although the target 40% decrease in density hasn't been achieved we are trending in the right direction following two treatments. Overstory tree density did not significantly change following two prescribed burns but is trending upward (Figure 2). Late winter / early spring burns are generally low intensity and do not cause mortality in large diameter oak trees due to bark insulation. Growing season burns (early spring / late summer) would increase the likelihood of overstory mortality.

Figure 1 Change in pole tree density (DBH 2.5 – 15.0 cm) within the glade / woodland transition monitoring type after two prescribed burns at Ozark National Scenic Riverways. X axis represents (# of prescribed burns and the # of growing seasons after burn) Bars represent SE of the mean. 13 plots included in analysis.

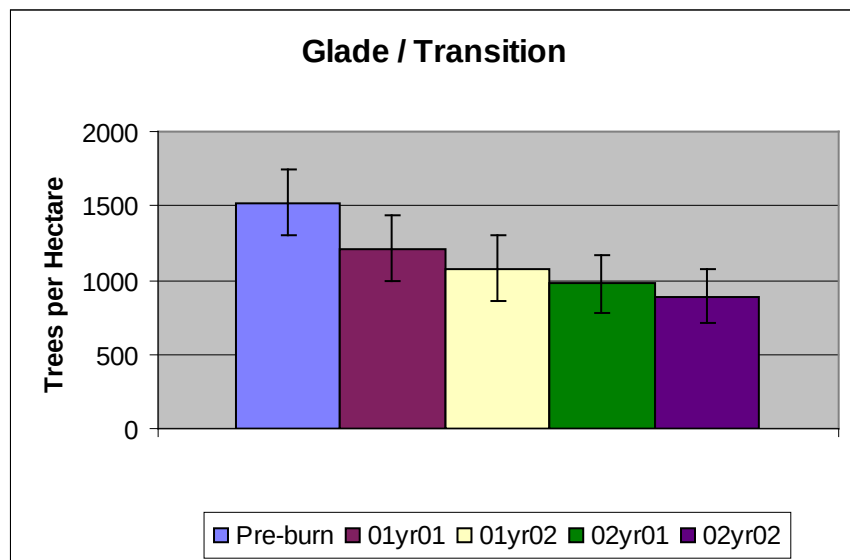
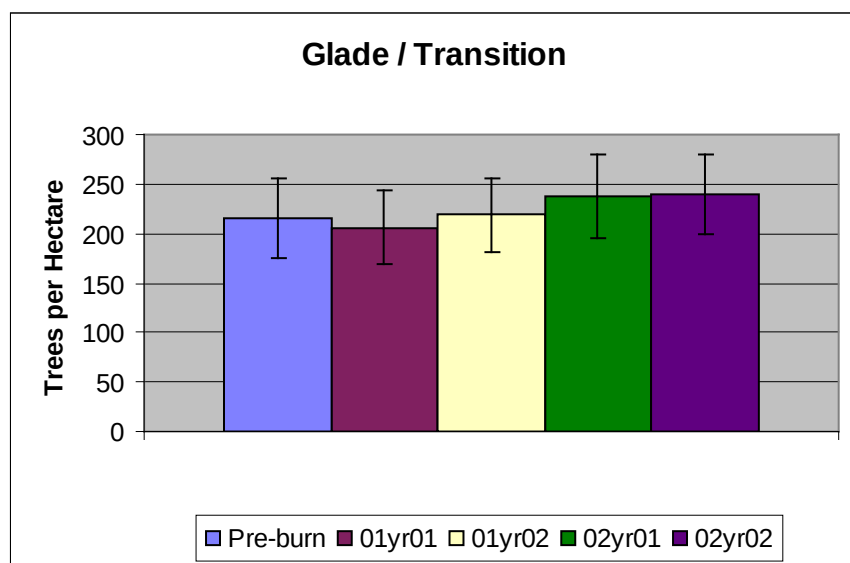


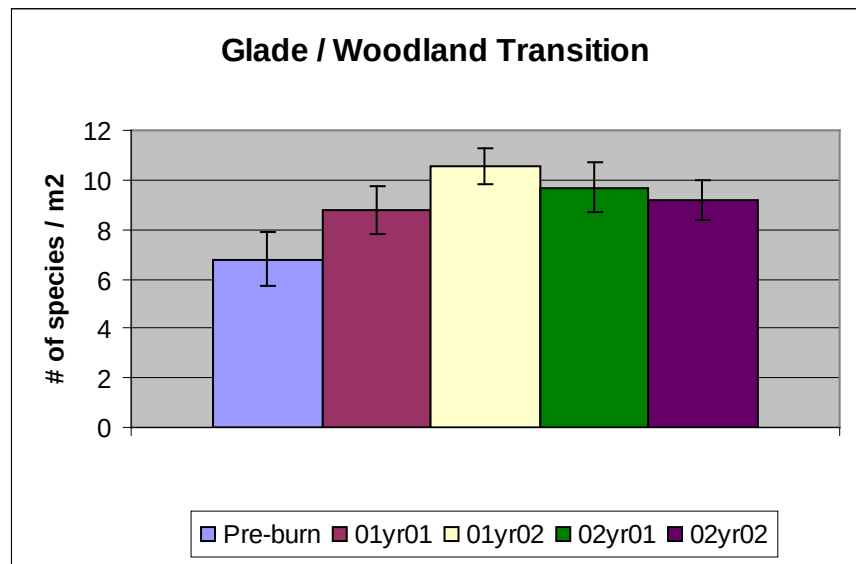
Figure 2 Change in overstory tree density (DBH $\geq$ 15.0 cm) within the glade / woodland transition monitoring type after two prescribed burns at Ozark National Scenic Riverways. X axis represents (# of prescribed burns and the # of growing seasons after burn) Bars represent SE of the mean. 13 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Species Richness

Herbaceous species richness pre-burn to second growing season after second burn was analyzed and there was a 90% certainty of at least a 29% increase (Figure 3). I would expect this increase in species diversity to continue with successive burn treatments as the canopy opens further.

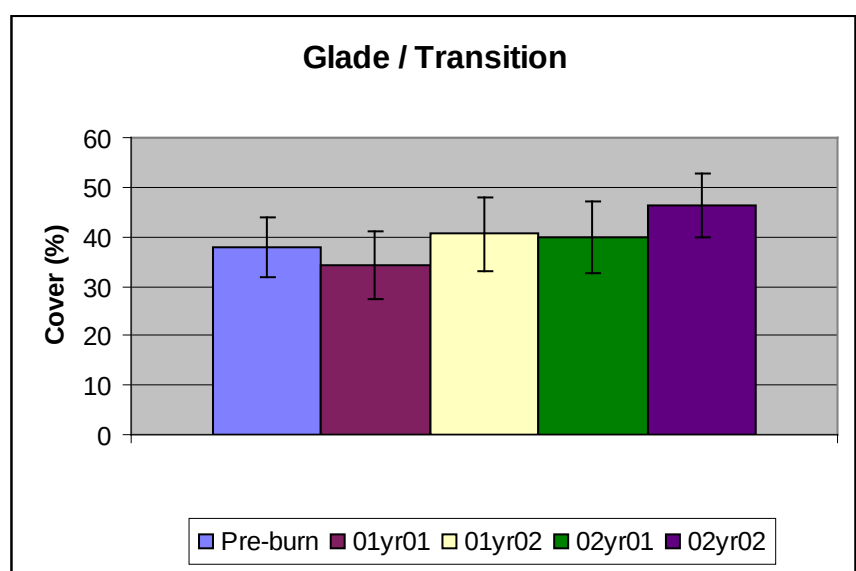
Figure 3 Herbaceous species richness within the glade / woodland transition monitoring type after two prescribed burns at Ozark National Scenic Riverways. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 13 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Plant Cover

Herbaceous species cover pre-burn to second growing season after second burn was analyzed and there was a 90% certainty of at least a 4% absolute increase in cover (Figure 4). This increasing trend in herbaceous cover is probably attributed to the increase in incident light from pole mortality.

Figure 4 Herbaceous plant cover within the glade / woodland transition monitoring type after two prescribed burns at Ozark National Scenic Riverways. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 12 plots included in analysis.



Dry Mesic Woodland Monitoring Type

I looked at relative change in overstory and pole density and species richness after two prescribed burns. Absolute change in herbaceous plant cover was also analyzed following two burns.

Effect of Prescribed Fire on Overstory and Pole Tree Density

There is an 80% certainty of at least a 49% decline in pole density two growing seasons after the second burn, which is well above the objective of a 30% decline (Figure 5). Overstory tree density did not significantly decline after two burns (Figure 6).

Figure 5 Change in pole tree density (DBH 2.5 - 15.0 cm) within the dry-mesic woodland monitoring type after two prescribed burns at Ozark National Scenic Riverways. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 9 plots included in analysis.

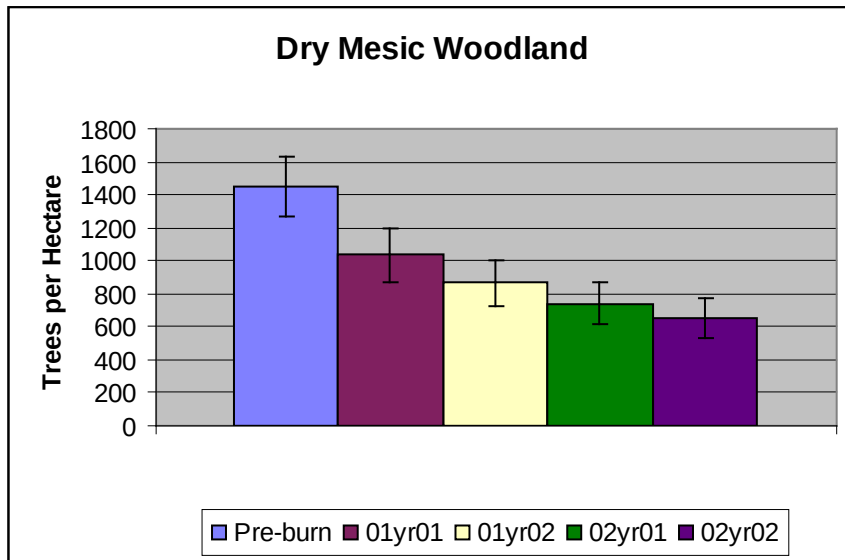
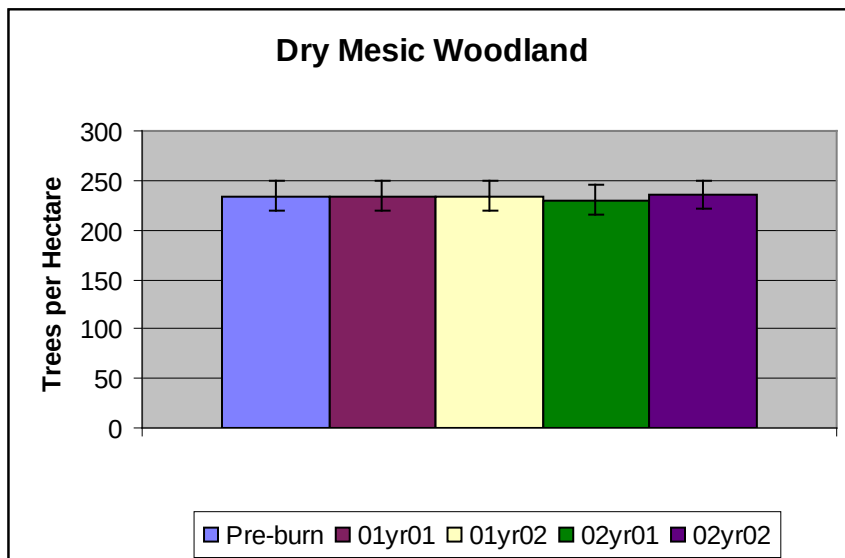


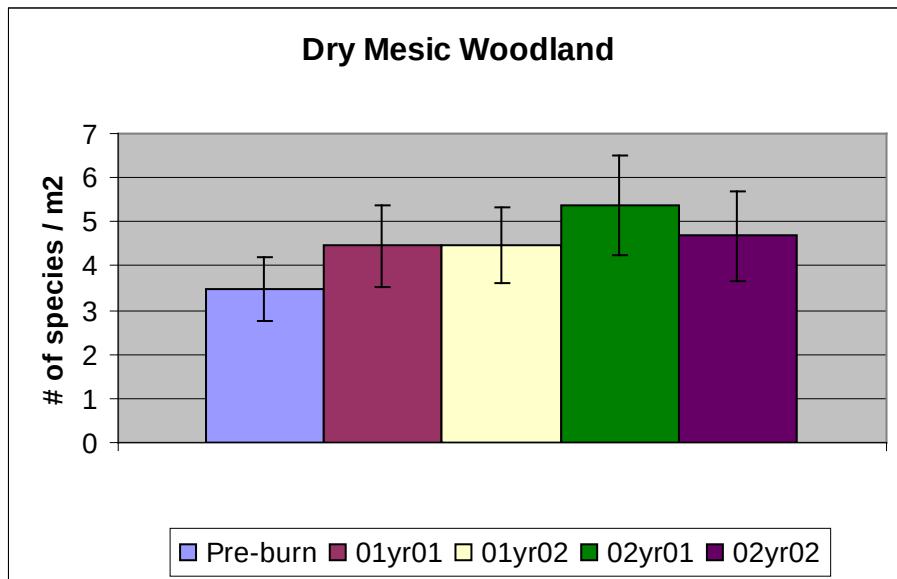
Figure 6 Change in overstory tree density (DBH $\geq$ 15.0 cm) within the dry-mesic woodland monitoring type after two prescribed burns at Ozark National Scenic Riverways. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 9 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Species Richness

There is a 90% certainty that a 15% increase in species richness occurred from pre-burn to two growing seasons after the second prescribed burn (Figure 7). Although short of the 20% objective, species diversity is trending upward.

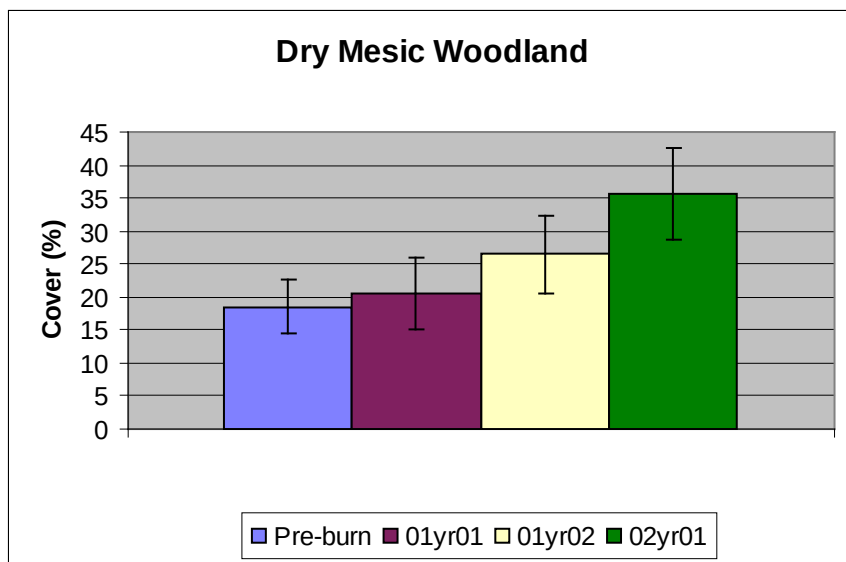
Figure 7 Change in herbaceous species richness within the dry-mesic woodland monitoring type after two prescribed burns at Ozark National Scenic Riverways. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 9 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Plant Cover

Herbaceous species cover pre-burn to first growing season after second burn was analyzed and there was a 90% certainty of at least a 12% absolute increase in cover (Figure 8). This significant increase in herbaceous cover is attributed to the increase in light from pole mortality.

Figure 8 Herbaceous plant cover within the dry-mesic woodland monitoring type after two prescribed burns at Ozark National Scenic Riverways. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 9 plots included in analysis.



Dry Woodland Monitoring Type

I looked at relative change in overstory and pole density and species richness after three prescribed burns. Absolute change in herbaceous plant cover was also analyzed following three burns.

Effect of Prescribed Fire on Overstory and Pole Tree Density

There is an 80% certainty of at least a 63% decrease in pole density two growing seasons after the third prescribed fire (Figure 9) and this is well above the objective of a 30% decrease following two burns. Overstory density significantly decreased by at least 10% after three prescribed burns (Figure 10) but is still higher than desired conditions.

Figure 9 Change in pole tree density (DBH 2.5 - 15.0 cm) within the dry woodland monitoring type after three prescribed burns at Ozark National Scenic Riverways. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 6 plots included in analysis.

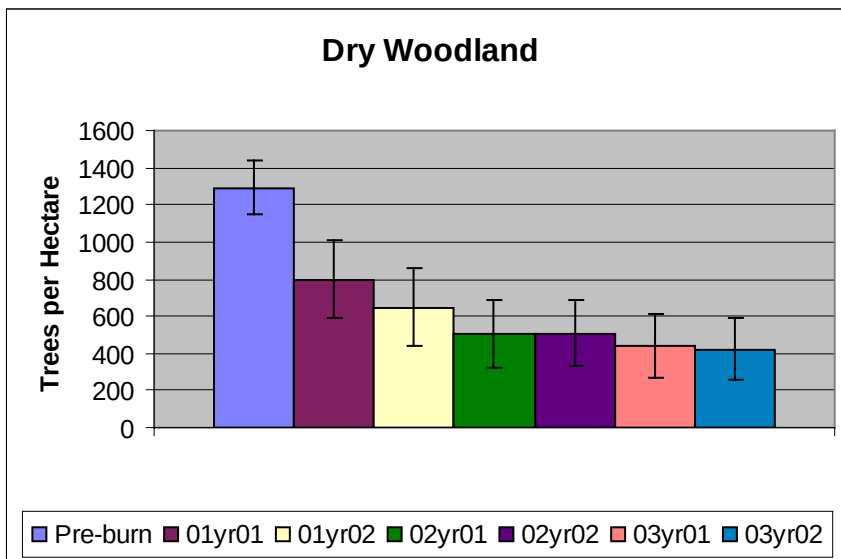
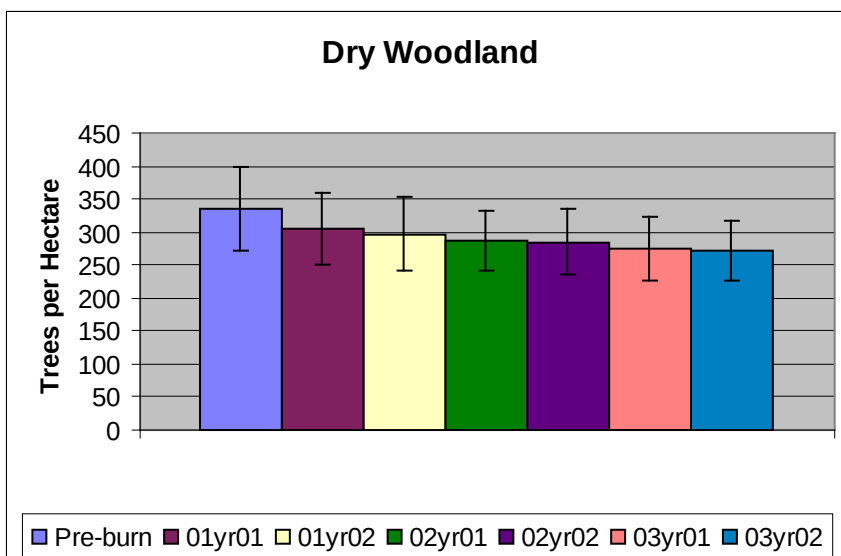


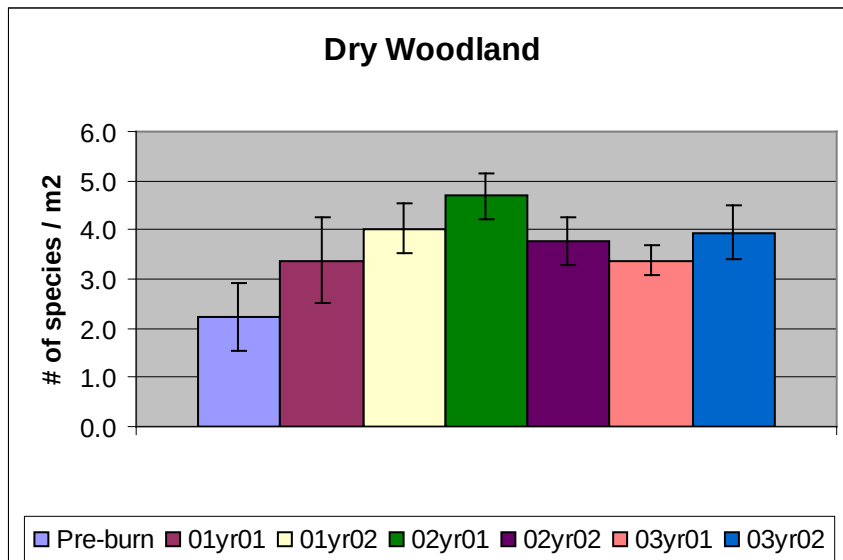
Figure 10 Change in overstory tree density (DBH $\geq$ 15.0 cm) within the dry woodland monitoring type after three prescribed burns at Ozark National Scenic Riverways. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 6 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Species Richness

There is a 90% certainty that the herbaceous species richness increased at least 25% two growing seasons after the third prescribed burn treatment, but is short of the 40% objective (Figure 11).

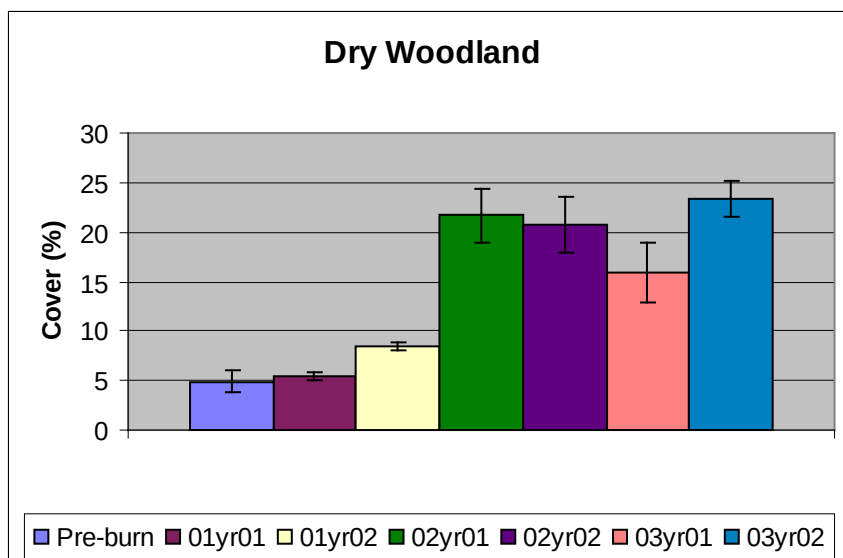
Figure 11 Change in herbaceous species richness within the dry woodland monitoring type after three prescribed burns at Ozark National Scenic Riverways. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 6 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Plant Cover

Herbaceous species cover pre-burn to second growing season after the third burn was analyzed and there was a 90% certainty of at least a 16% absolute increase in cover (Figure 12). This significant increase in cover is most likely attributed to higher incident light coming to the ground due to mid story mortality.

Figure 12 Herbaceous plant cover within the dry woodland monitoring type after three prescribed burns at Ozark National Scenic Riverways. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 6 plots included in analysis.



Buffalo National River

The effect of two prescribed burns on overstory and pole density was monitored at Buffalo National River within the Lower Wilderness burn unit. Seven dry woodland and eight glade / transition permanent monitoring plots were installed during the summer of 2001 and 2002. Analysis was completed on all of the dry woodland plots and six of the glade / transition plots (since two glades didn't burn during the first treatment and were thus excluded for analysis). The prescribed burns were conducted on March 10, 2004, and March 6, 2007. These were the first two prescribed burns conducted in this wilderness area.

Dry Woodland Monitoring Type

Effect of Prescribed Fire on Overstory and Pole Density

There is an 80% certainty of at least a 57% decrease in pole density two growing seasons after the second prescribed burn treatment (Figure 13). This falls just short of the objective 60% after only five years. Overstory tree density remains unchanged after two burns and will need growing season burns in order for the tree density to decrease (Figure 14).

Figure 13 Change in pole tree density (DBH ≥ 2.5 and < 15.0 cm) within the dry woodland monitoring type after two prescribed burns at Buffalo National River. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 7 plots included in analysis.

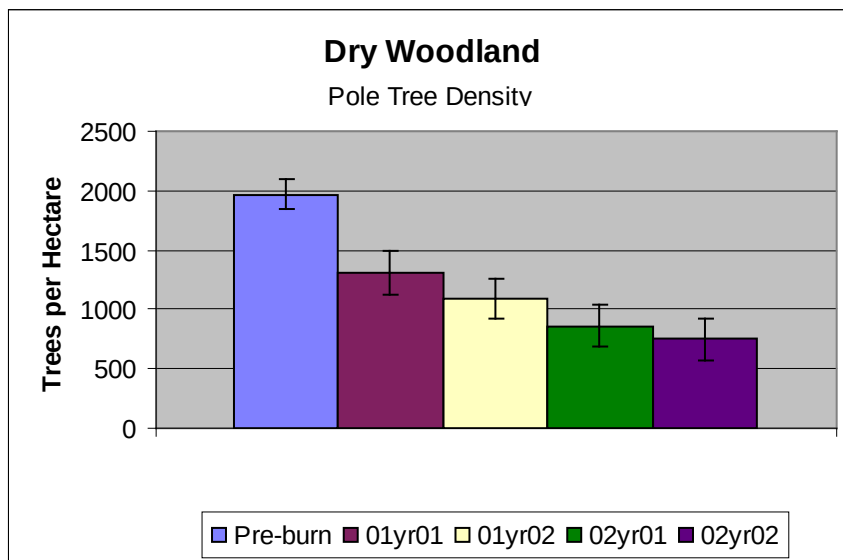
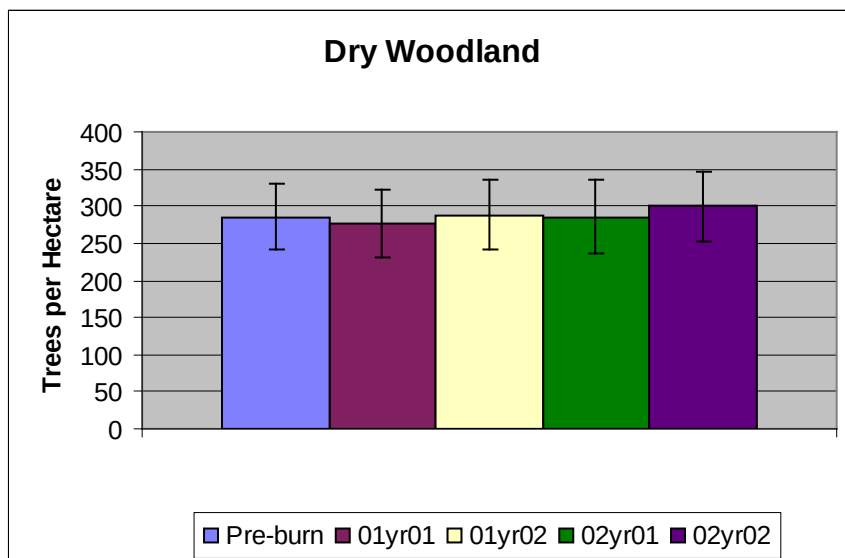


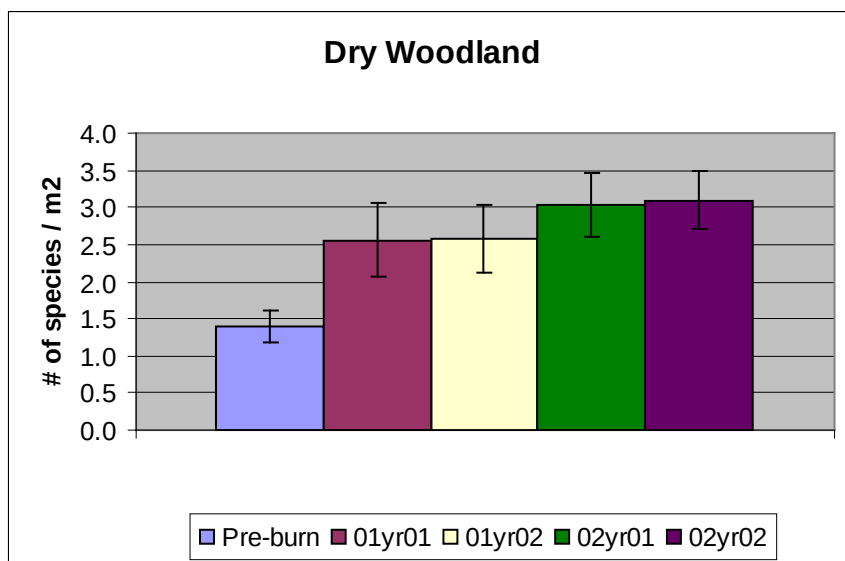
Figure 14 Change in overstory tree density (DBH ≥ 15.0 cm) within the dry woodland monitoring type after two prescribed burns at Buffalo National River. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 7 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Species Richness

There is a 90% certainty that the herbaceous species richness increased at least 94% two growing seasons after the second prescribed burn treatment (Figure 15). Species richness has increased after each burn probably due to increases in incident light from pole tree mortality.

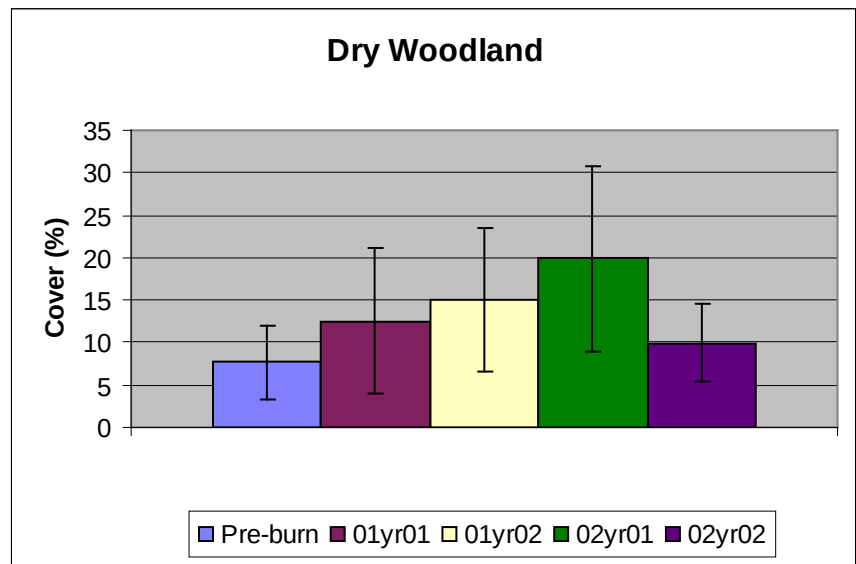
Figure 15 Change in herbaceous species richness within the dry woodland monitoring type after two prescribed burns at Buffalo National River. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 7 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Plant Cover

Herbaceous species cover pre-burn to second growing season after the second burn was analyzed and there was a 90% certainty of at least a 2% absolute increase in cover (Figure 12). The decrease in cover from first to second growing season following the second burn treatment is puzzling and not expected. This could be due to different meteorological conditions between the two years. Future reads will help determine if this is a trend or anomaly.

Figure 16 Herbaceous plant cover within the dry woodland monitoring type after two prescribed burns at Buffalo National River. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 7 plots included in analysis.

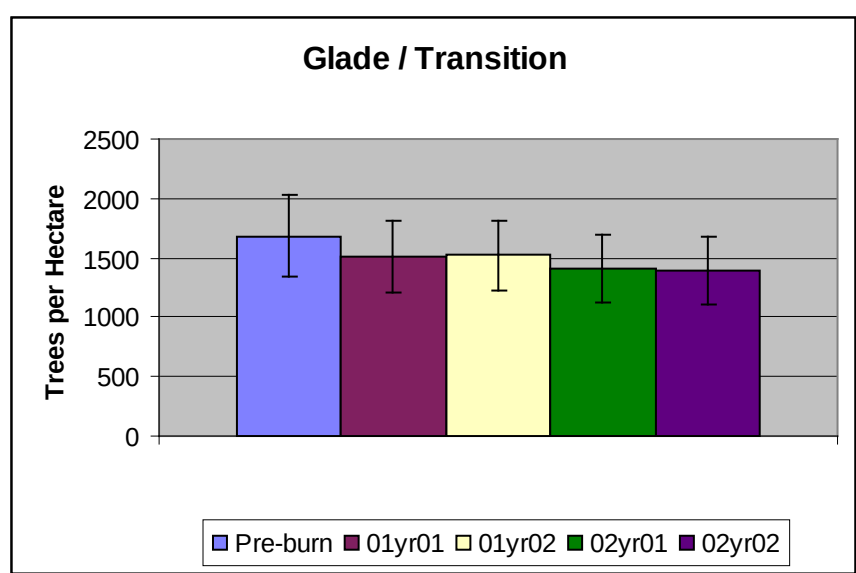


Glade & Transition Monitoring Type

Effect of Prescribed Fire on Pole Density

Following two prescribed burns in four years, pole density significantly decreased by at least 12% with an 80% certainty (Figure 16). This is short of the 60% objective, but the timeframe of 10 years of burning has not been reached.

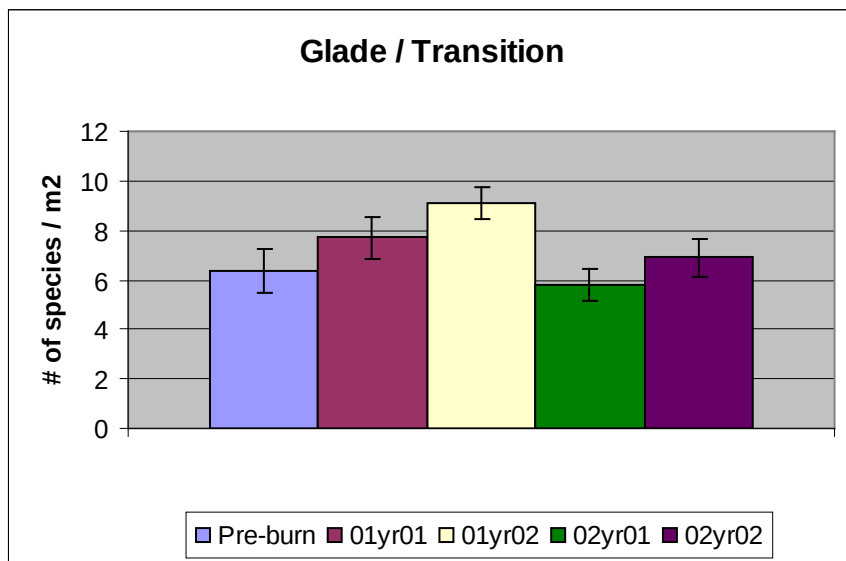
Figure 16 Change in pole tree density (DBH ≥ 2.5 and < 15.0 cm) within the glade and transition monitoring type after two prescribed burns at Buffalo National River. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 6 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Species Richness

Following two prescribed burns and two growing seasons there was no significant change in species richness (Figure 17). I hypothesized that the significant decrease from 01yr02 to 02yr01 was due to the late spring freeze in 2007 which set back all the vegetation by over a month. The species diversity for the 02yr02 read is now trending upward again.

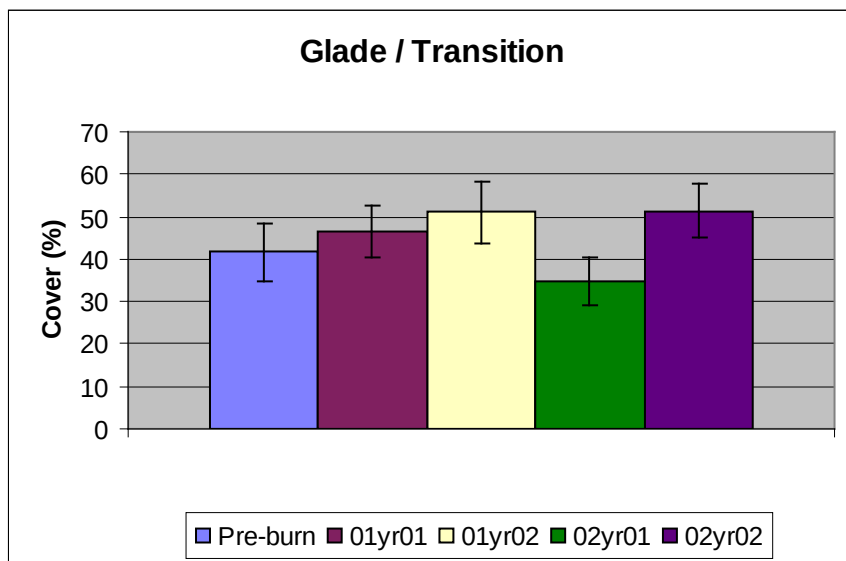
Figure 17. Change in herbaceous species richness following two prescribed burns at Buffalo National River within the Glade & Transition monitoring type. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 6 plots included in analysis.



Effect of Prescribed Fire on Native Herbaceous Plant Cover

After two prescribed burns and two growing seasons, there is a 90% certainty that absolute change in herbaceous cover significantly increased by at least 3% (Figure 18). Herbaceous cover dropped for the 02yr01 read due to the hard freeze in April 2007, but now has bounced back after another growing season.

Figure 18. Herbaceous cover following two prescribed burns at Buffalo National River within the glade and transition monitoring type. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 6 plots included in analysis.



Pea Ridge National Military Park

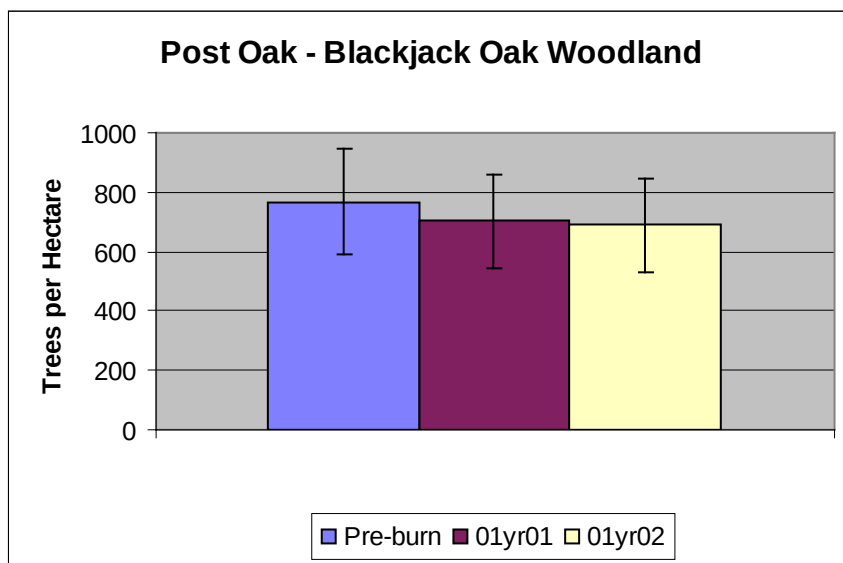
Post Oak - Blackjack Oak Woodland Monitoring Type

Five plots from three burn units were used to assess the effect of one prescribed fire on overstory and pole density, herbaceous species richness, and herbaceous plant cover.

Effect of Prescribed Fire on Overstory and Pole Tree Density

After one prescribed burn, there is an 80% certainty that pole density significantly decreased by at least 6% (Figure 19). Overstory density was unchanged after one burned at approximately 355 trees per hectare.

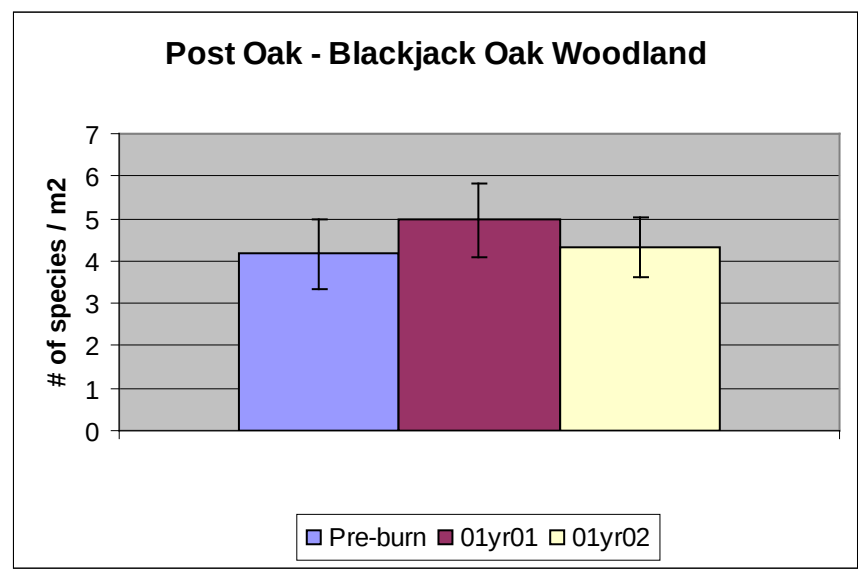
Figure 19 Change in pole tree density (DBH ≥ 2.5 and < 15.0 cm) within the post oak – blackjack oak woodland monitoring type after one prescribed burn at Pea Ridge National Military Park. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 5 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Species Richness

Herbaceous species richness has not changed after one application of fire (Figure 20) probably due to no increase in incident light reaching the ground. As noted above, there was no mortality in overstory trees with one burn treatment and only a minor decrease in pole density. A growing season burn is necessary to decrease overstory and pole densities within this monitoring type.

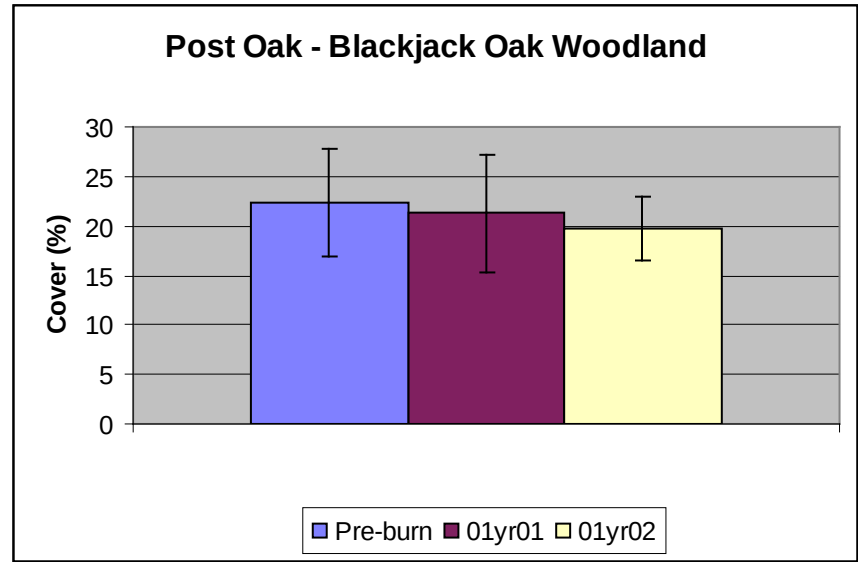
Figure 20. Change in herbaceous species richness following one prescribed burn at Pea Ridge National Military Park within the post oak – blackjack oak woodland monitoring type. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 5 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Plant Cover

Herbaceous plant cover did not significantly change from the preburn average of 22% following one prescribed burn (Figure 21). Restoration of the species diversity and herbaceous cover of this monitoring type necessitate bringing more incident light to the ground by decreasing overstory / pole density and basal area.

Figure 21. Change in herbaceous plant cover following one prescribed burn at Pea Ridge National Military Park within the post oak – blackjack oak woodland monitoring type. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 5 plots included in analysis.



Oak Hickory Woodland Monitoring Type

Three plots from one burn unit were used to assess the effect of one prescribed fire on overstory and pole density, herbaceous species richness, and herbaceous plant cover.

Effect of Prescribed Fire on Overstory and Pole Tree Density

There is an 80% certainty of at least an 18% decrease in pole density five growing seasons after one burn (Figure 22). Overstory density also showed a significant decrease of at least 8% (Figure 23). As more prescribed burn treatments are implemented both overstory and pole densities should continue to decrease and reach management objectives.

Figure 22 Change in pole tree density (DBH ≥ 2.5 and < 15.0 cm) within the oak hickory woodland monitoring type after one prescribed burn at Pea Ridge National Military Park. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 3 plots included in analysis.

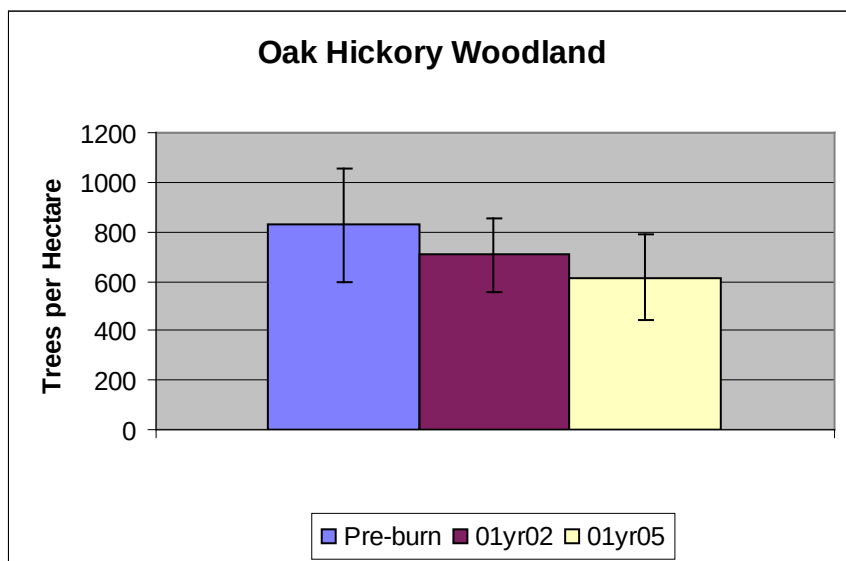
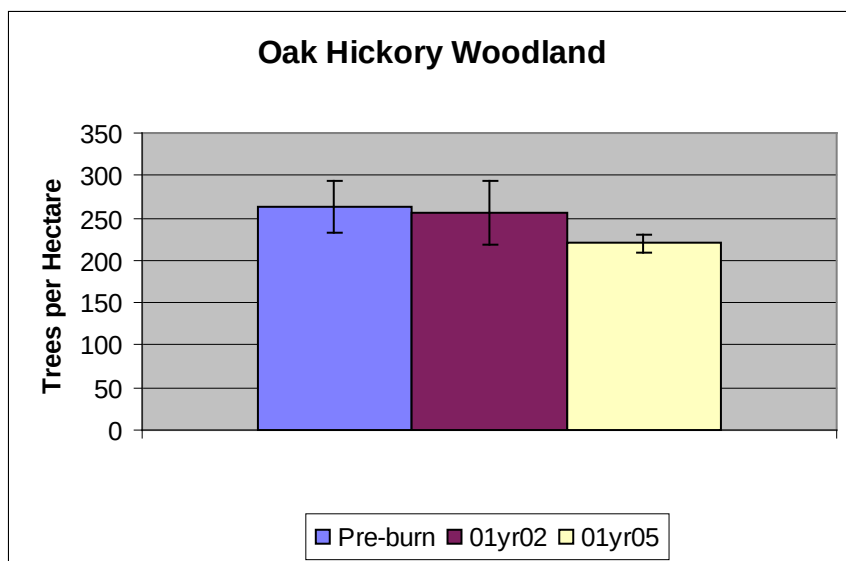


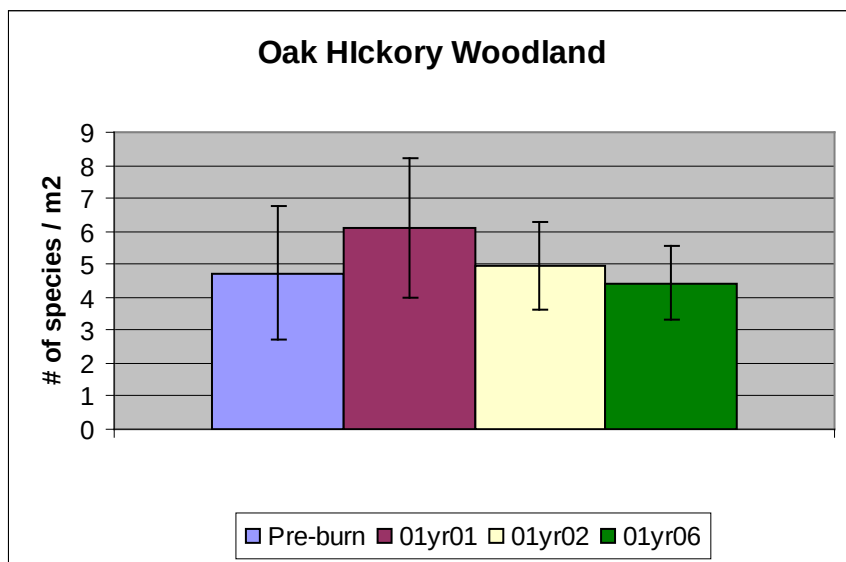
Figure 23 Change in overstory tree density (DBH ≥ 15.0 cm) within the oak hickory woodland monitoring type after one prescribed burn at Pea Ridge National Military Park. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 3 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Species Richness

Herbaceous species richness has not significantly changed from pre-burn conditions six years after one application of fire (Figure 24). Species richness peaked the first growing season after the burn and has since been on a downward trend. A second and third burn should return this trend in a positive direction. Litter and duff has accumulated for the past six years and is probably inhibiting an increase in species diversity.

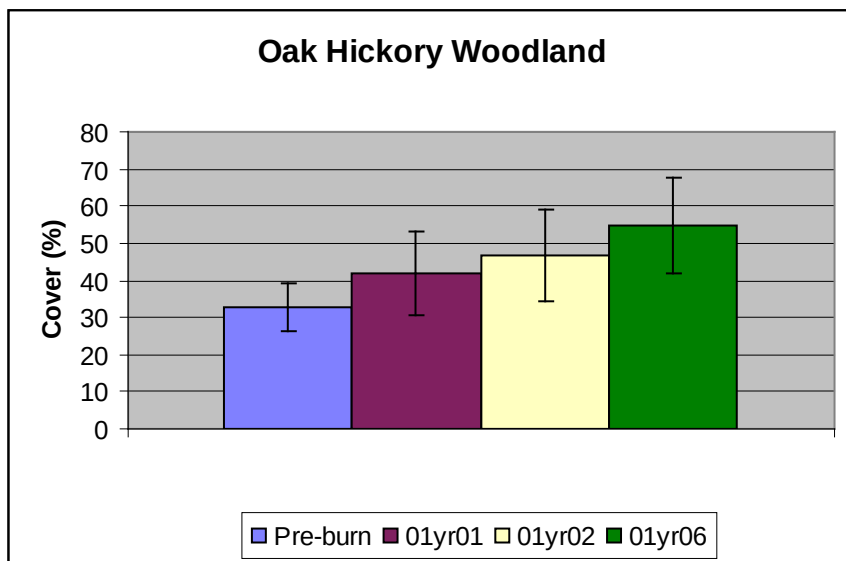
Figure 24. Change in herbaceous species richness following one prescribed burn at Pea Ridge National Military Park within the oak hickory woodland monitoring type. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 3 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Plant Cover

There is a 90% certainty that a 10% absolute increase in herbaceous cover occurred between pre-burn and six growing seasons after the first prescribed burn treatment (Figure 25).

Figure 25. Change in herbaceous plant cover following one prescribed burn at Pea Ridge National Military Park within the oak hickory woodland monitoring type. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 3 plots included in analysis.



Hot Springs National Park

The effect of applying one prescribed burn treatment on overstory and pole density, herbaceous species richness, and herbaceous cover was monitored at Hot Springs National Park.

Effect of Prescribed Fire on Overstory and Pole Tree Density

There was an 80% certainty of at least a 41% decrease in pole density and 6% decrease in overstory density one growing season after the first prescribed burn treatment (Figures 26 & 27).

Figure 26 Change in pole tree density (DBH ≥ 2.5 and < 15.0 cm) after one prescribed burn at Hot Springs National Park. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 7 plots included in analysis.

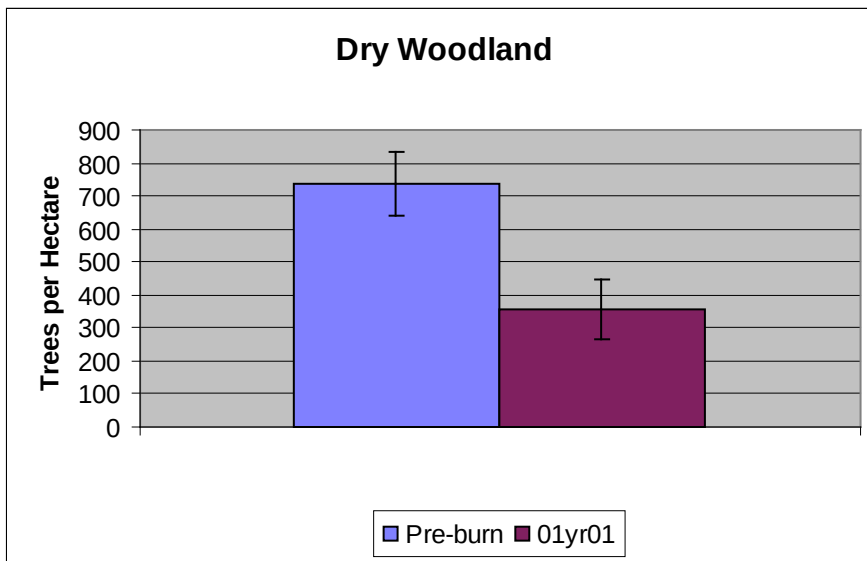
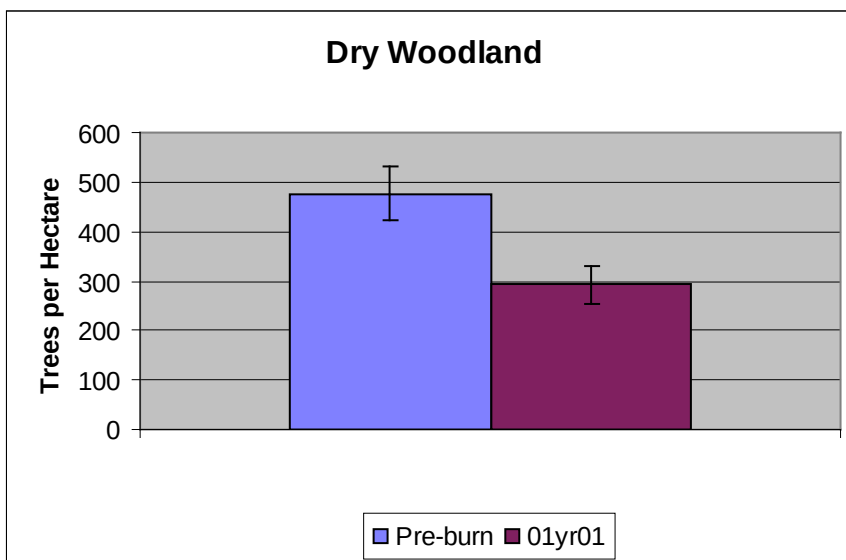


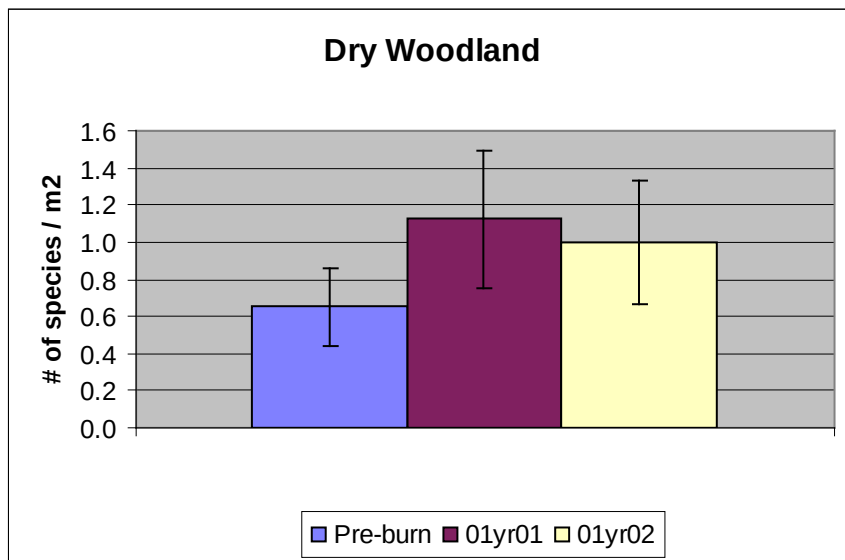
Figure 27 Change in overstory tree density (DBH ≥ 15.0 cm) after one prescribed burn at Hot Springs National Park. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 7 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Species Richness

There is an 80% certainty of at least a 57% increase in herbaceous species richness the first growing season after the burn (Figure 28). Significant decreases in overstory and pole density allowed more light to reach the ground and bring this positive trend.

Figure 28. Change in herbaceous species richness following one prescribed burn at Hot Springs National Park. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 4 plots included in analysis.



Effect of Prescribed Fire on Herbaceous Plant Cover

Native herbaceous cover is trending upward from pre-burn conditions but is statistically insignificant due to the high variability of the cover data (Figure 29). As more monitoring plots are added to the park and burns implemented, we should be able to detect changes in cover.

Figure 29. Change in herbaceous plant cover following one prescribed burn at Hot Springs National Park. X axis represents # of prescribed burns and the # of growing seasons after burn. Bars represent SE of the mean. 4 plots included in analysis.

