



**National Park Service
Fire Ecology Annual Report
Calendar Year 2004**

Summary

The NATR crew continues to work hard to learn the FMH sampling protocol and the vast plant diversity in our expanding number of cluster parks. Considerable effort was spent learning the FEAT program, and preparing for the transition from the FMH software. As a result of the work of Lead Monitor Andrew Ruth, all plots at all parks are now georeferenced, mapped, and organized with associated metadata. The data shift from all parks that were being transitioned to the care of the NATR crew is complete, but the GRSM crew graciously provided field assistance as needed and for this we are indebted. In addition to monitoring in the host and 5 cluster parks, the NATR crew began their first season of monitoring work at Horseshoe Bend National Military Park in December of 2004.

This year was a challenging year for the Natchez Trace Fire Effects Monitoring crew, and for much of the year the crew functioned with only the lead monitor and the ecologist. In May 2004, both GS-5 monitors were furloughed for 4 months. Neither of the monitors returned from furlough; one monitor, Kim Judson, was accepted into graduate school, and the other monitor, Mandi Callis, was promoted to fuels technician at the Parkway.

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
NATR	Loblolly Pine (<i>Pinus taeda</i>)	FMH Forest Plot	1	3	4	8
NATR	Eastern Red Cedar (<i>Juniperus virginiana</i>)	FMH Brush Plot		4		4
LIRI	Shortleaf Pine (<i>Pinus echinata</i>)	FMH Forest Plot	1		9	10
LIRI	Chestnut Oak (<i>Quercus montana</i>)	FMH Forest Plot	1		2	3
LIRI	Green Pitcher Plant (<i>Sarracenia oreophila</i>)	FMH Forest Plot			4	4
MACA	Big Bluestem (<i>Andropogon gerardii</i>)	FMH Grass Plot		3		3
MACA	Eastern Red Cedar (<i>Juniperus virginiana</i>)	FMH Forest Plot		5		5
MACA	Chestnut Oak (<i>Quercus montana</i>)	FMH Forest Plot			1	1
MACA	Indiangrass (<i>Sorghastrum nutans</i>)	FMH Brush Plot			3	3
GUIS	Longleaf and Slash Pine (<i>Pinus palustris</i> and <i>P. elliottii</i>)	FMH Forest Plot			9	9
GUIS	Sand Pine (<i>Pinus clausa</i>)	FMH Forest Plot			2	2
GUIS	Yellow Trumpets (<i>Sarracenia alata</i>)	FMH Forest Plot			1	1
STRI	Little Bluestem (<i>Schizachyrium scoparium</i>)	FMH Grass Plot	1			1
STRI	Splitbeard Bluestem (<i>Andropogon ternarius</i>)	FMH Grass Plot	2			2
HOBE	Longleaf Pine (<i>Pinus palustris</i>)	FMH Forest Plot	2			2
Total			8	15	35	58

*Note: Aside from the eastern red cedar brush plots at NATR, a portion of all monitoring units is being pilot sampled.

Table 2. Fire Ecology Staffing 2004

Name	Position	Starting Date	Ending Date	# of Pay Periods	Training and Development
Lisa McInnis	Fire Ecologist	01/01/04	12/31/04	26	S-110, SA-120, S-110/133, I-100 Vegetation Monitoring in a Management Context FEAT/Statistical Training
Andrew Ruth	Lead Monitor	01/01/04	12/31/04	26	SA-120, S-110/133, I-100 S-281 Live Fuel Moisture Training FEAT Training Vegetation Monitoring in a Management Context ESRI online training
Amanda Callis	Monitor	01/01/04	10/1/04 (furlough 5/3-9/20/04)	10	S-110, SA-120, S-110/133, I-100 S-281, S-211
Kimberly Judson	Monitor	1/1/04	8/20/04 (furlough 5/3-8/20/04)	8	S-110, SA-120, S-110/133, I-100 S-211, S-131

Table 3. Management Objectives and Monitoring Results 2003

All results shown are 80% confidence intervals of the mean unless otherwise noted. Fuel reduction objectives/results are mean percent reduction from preburn to immediate postburn, unless otherwise stated. An underlined number of plots denote that minimum sample sizes have been achieved.

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (80% confidence interval)	Objective Achieved? (minimum plots achieved/needed)
GUIS¹ FPICL1D07 Sand pine-scrub oak forest <i>Pinus clausa</i>	20-40% litter and duff reduction ² immediate postburn (Year 2 data presented as no 01 Post data is available)	Litter/duff increase of approximately 10% per year ³ . (n=5, 1 fire) Figure 1	No- but minimum sample size not met (5/15)
	40-60% reduction of sand pine poles by 2 nd year after 3 rd burn	Sand pine pole density reduction =11% by Year 2) (n=5, 1 fire) Figure 2	No- but minimum sample size not met (5/13)
	50-90% hardwood pole reduction by Year 1	Pole density reduction = 25% by Year 2). (n=5, 1 fire) Figure 3	No- but minimum sample size not met (5/13)
	20-40% increase in herbaceous cover by 2 nd year after 3 rd burn	Increase in relative cover = 23% by Year 2 (n=3, 1 Fire) Figure 4	No-but but minimum sample size not met and 3 burns not achieved
GUIS FPIPA1D07 Longleaf-slash pine forest <i>Pinus palustris</i>	50-90% hardwood pole reduction by Year 1	Hardwood pole density reduction =56% by Year 1 (n=9, 1 fire) Figure 5	Yes, but minimum sample size not met (9/19)
	20-40% litter and duff reduction immediate postburn (Year 1 data presented)	Litter and duff reduction = 37% by Year 1 (n=5, 1 fire) Figure 6	Yes- but minimum sample size not met (7/24 with R=25)
	20-40% increase of herbaceous cover by 2 nd year after 3 rd burn	Cover change =-21% by Year 1 (n=10, 1fire) Figure 7	No- but minimum sample size not met (10/34 with R=25)

¹ No new installations were performed at GUIS due to uncertainty regarding burning, therefore many minimum plot calculations are the same as last year.

² Year 1 and Year 2 postburn fuels data was averaged across plot data taken 12-19 months postburn (for Year 1) and 24-33 months postburn (for Year 2; see GUIS monitoring schedule for details).

³ Area was hit by Hurricane Ivan in 9/04; data from two post-hurricane plots included here.

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (80% confidence interval)	Objective Achieved? (minimum plots achieved/needed)
GUIS FSAAL1D07 Pitcher plant forest <i>Sarracenia alata</i>	40-90% pole density reduction by Year 1	No change (n=1, 1 fire)	No- but minimum sample size not met ⁴
	20-40% increase of herbaceous cover by 2 nd year after 3 rd burn	Herbaceous cover change was -5% ⁵ by Year 1 (n=1, 1 fire) Figure 8	No- but minimum sample size and required number of fires not met
	20-40% decrease in litter and duff loading immediately postburn	Average litter/duff reduction = 49% ⁶ (n=1, 1 fire) Figure 9	Yes, but minimum sample size not met
LIRI FPIEC1DG09 Shortleaf pine forest <i>Pinus echinata</i>	25-80% reduction in pole-sized trees by 3 rd burn	Pole reduction = 50% by Year 2. (n= <u>10</u> , 1 fire) Figure 10	Yes
	25-50% increase native grass and forb cover	Average forb and grass cover increase = 42% ⁵ (n=3, 1 fire) Figure 11	Yes, but minimum sample size not met
	25-50% reduction in downed woody fuel and litter/duff by 3 rd burn	Average fuel load reduction = 22% (n= <u>9</u> plots, 1 fire) Figure 12	No, but required number of fires not met

⁴ Need additional plot before minimum sample size can be estimated.

⁵ Season of postburn read for the SAAL plot did not coincide with preburn read. Plot will be reevaluated in Spring 2005.

⁶ Result is same as last year because no additional plots were installed.

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (80% confidence interval)	Objective Achieved? (minimum plots achieved/needed)
LIRI FSAOR1G10⁷ Green pitcher plant forest <i>Sarracenia oreophila</i>	30-90% decrease in pole-sized trees by second year after 3rd burn.	Pole reduction = 7% by Year 2 (n=3, 1 fire) Figure 13	No- but minimum sample size and required number of fires not met (3/9).
	40-90% decrease in shrub cover by second year after 3rd burn	Increase in shrub cover of 19% by Year 2. (n=3, 2 fires) Figure 14	No- but minimum sample size and required number of fires not met (3/16)
	20% increase cover of <i>S. oreophila</i> by second year after 3 rd burn	Increase in <i>S. oreophila</i> cover of 28% by Year 2. (n=3, 2 fires) Figure 15	Yes- but minimum sample size and required number of fires not met (3/89)
	25% reduction in litter and duff fuel load	Litter and duff reduction =45% by Year 2 (n=5, 1 fire) Figure 16	Yes (on plots but not monitoring type as a whole; see footnote 7).
LIRI FQUMO1G10 Chestnut oak-dominated forests <i>Quercus montana</i>	20-60% reduction in pole-sized trees	Pole density reduction = 28% by Year 2. (n=2, 1 fire) Figure 17	Yes- but minimum sample size not met
	25-50% increase native grass and forb cover	Increase in native forb cover =50% between Year 1 and Year 2. (n=2, 1 fires) Figure 18	No- but minimum sample size not met (2/35 with R=25)
	25-50% reduction in total fuel load	Total reduction =27% by Year 2 (n=2 1 fire) Figure 19	Yes- but minimum sample size not met (2/4)

⁷ Plots within the SAOR monitoring type are not randomly distributed; plots were installed to encompass existing *Sarracenia* populations.

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (80% confidence interval)	Objective Achieved? (minimum plots achieved/needed)
MACA BSONU1T02 Indian grass grassland <i>Sorghastrum nutans</i>	Reduce density of shade tolerant seedlings 30% to 60% one year after second fire.	Seedling reduction = 47% by Year 1 (n=3 plots, 1 fire) Figure 20	Yes- but minimum sample size not met (3/14)
	Reduce density of shrubs 30% to 60% one year after second fire.	Shrub density reduction = 27% by Year 1 (n=3 plots, 1 fire) Figure 21	No- but minimum sample size not met (3/14)
	Cause no net gain in percent cover of exotic plants (Japanese honeysuckle) after five years of burning	Average reduction = 71% by Year 1. (n=3, 1 fire) Figure 22	Yes- but minimum sample size not met (3/14).
	Increase relative cover of <i>Sorghastrum nutans</i> 15% after five years of burning	Increase of 19% by 4 months postburn ⁸ (n=3 plot, 1 fire) Figure 23	Yes- but minimum sample size not met (3/14)
MACA FQUMO1D09 Chestnut oak forest <i>Quercus montana</i>	Decrease density of shade tolerant pole trees by 30-90%	Average reduction 55% by Year 2 (<i>Cornus florida</i> and <i>Fagus grandifolia</i>) (n=1 plot, 1 fire) Figure 23	Yes- but minimum sample size not met
	Limit mortality of overstory trees to less than 20%	Average density reduction 4% by Year 2. (n=1, 1 fire) Figure 24	Yes- but minimum sample size not met
MACA FJUVI1D09 Red cedar glade forest <i>Juniperus virginiana</i>⁹	Reduce litter/duff and downed woody fuel load by 25-50%	Average reduction was 4% immediately postburn. (n=5, 1 fire) Figure 25	No, but minimum sample size not met (5/12)

⁸ No available data for Year 1 postburn until October 2005.

⁹ Pole density reduction and overstory mortality objectives for the red cedar monitoring type cannot be examined until Year 1 data has been collected. Data from the *Andropogon gerardii* monitoring type (woody species density, fuel load and exotic cover) cannot be analyzed on the monitoring type until Year 1 data has been collected. (2005)

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (80% confidence interval)	Objective Achieved? (minimum plots achieved/needed)
NATR FPITA1D09 Loblolly pine forest <i>Pinus taeda</i>	Reduce total fuel load by 20-40% immediate postburn	Fuel load reduction = 40% by Year 1. (n=7, 1 fire). Figure 26	Yes
	Reduce conifer poles (2.5-15.0 cm dbh) >25% one year post burn	Pole density reduction =12% by Year 1. (n=6, 1 fire) Figure 27	No, but minimum sample size not met (6/20)
	Cause no net gain in percent cover of exotic plants (e.g. kudzu, Chinese privet, Japanese honeysuckle, etc.) after 5 years of burning	No available data- 7 plots with no preburn data, and 5 plots that have not burned	Not Determined
NATR BJUV11D06 Blackbelt prairie <i>Juniperus virginiana</i>	25-50% reduction of <i>Juniperus virginiana</i> density after 5 years of burning	Density of <i>Juniperus virginiana</i> reduced by 9% after 3 rd burn. (n=4, 3 fires) Figure 28	No, but minimum sample size not met (4/14)

Ecologist Accomplishments

During the calendar year of 2004, the ecologist became the Park Ecologist Representative on the Fire Ecology Steering Committee, and attended the interdisciplinary meeting of ecologists, fuels managers, GIS specialists, and fire education specialists in Nebraska City (11/04). The NATR ecologist is also a member of the Fire Ecology Assessment Tool (FEAT) Conversion Working Group.

The ecologist was also involved in fire education, such as nature walks with area fourth grade classes during Fire Prevention Week, and lectures to undergraduate senior fire ecology students at Mississippi State University. In an effort to be involved in interagency matters, the ecologist attended a meeting of the Tennessee Fire Cooperators (comprised of the NPS, USFS, FWS, and State agencies) in Knoxville.

Planning document preparation, such as prescribed burn plans for 3 burn units at Stones River National Battlefield, was a focus for the ecologist in 2004. A large percentage of time was spent producing the Natchez Trace Fire Effects Monitoring Plan, which is currently in review. In addition, the ecologist served as a Contracting Officer's Representative, overseeing mechanical fuel reduction projects along the Natchez Trace.

Sampling Design & Field Methods; Changes in Protocols

Some significant changes in monitoring scheduling have taken place this year. Several plots at NATR, GUI, and LIRI were inadvertently monitored at year one or year two postburn intervals that did not coincide with the season of the pre-read (see respective parks' monitoring schedules for details). Therefore, the decision was made to read the herbaceous aspects of the affected plots during the next season that coincided with the pre-read; this data would suffice as the year one data (or year two data, in some cases). Out-of-season data for other variables less affected by seasonality (overstory, poles, fuels, and seedlings) were entered into FMH at the respective postburn month interval (i.e. Month 19 or Month 26).

Other changes in protocol for 2004 included reduction in the number of quadrants in which seedlings were counted at NATR. In the past, seedlings were counted in two entire quadrants. Since seedling diversity or abundance are not primary objectives for the monitoring types at NATR, the time required to monitor seedlings in two quadrants was not warranted and seedling work was therefore limited to 1 quadrant.

Program Challenges

The biggest challenges facing our program relate to acquisition and distribution of sound data. As it stands now, we are criticized for the complexity of our monitoring protocols and the lack of results. Whereas the NPS on the whole is striving to improve communication of results, it is still our biggest challenge. However, our sample sizes for all almost all monitoring units are not sufficient. In many cases the projected needed minimum plots are not attainable (or maintainable) by a crew of our size. Therefore, it seems likely that more streamlined monitoring protocols may be in order.

On a related topic, the monitoring program must be able to communicate with the public and with other agencies about whether or not objectives are being met. However, two additional challenges are (1) determining the objectives, and (2) how to create sound objectives that can be fulfilled. For example, one of the difficulties in creating realistic fuel load objectives for the program involves determining what levels of fuel accumulation after burning are acceptable; fuel reduction objectives are commonly met for immediate postburn reads, but what about for subsequent years? Therefore, realistic and adaptable objectives are another challenge faced by the program.

Status of Planning Documents

Work on the NATR Monitoring Plan is ongoing, with the draft document currently in review. In the upcoming year, the NATR Fire Management Plan will be updated. An updated Environmental Assessment will likely be contracted out for completion. The GUI Monitoring plan is being finalized in association with Sue Grace of the Fish and Wildlife Service. Fire Effects Monitoring Plans for MACA and VICK are scheduled for completion during FY05.

Monitoring Results

For each objective in each monitoring unit, minimum prefire plots and change over time were calculated. Exceptions are noted in Table 3. For all objectives, the 80% confidence interval was used. Average and minimum desired objectives are reported for each variable.

Research Projects/Collaboration

Perhaps the most significant collaboration for the NATR fire effects program is that of a contractual collaboration with Auburn University for monitoring work at Horseshoe Bend National Military Park. Currently, 2 fire effects monitoring plots have been established, and 2 additional plots are scheduled for installation in thinned longleaf pine areas.

Another area of collaboration for the NATR program is that of a Joint Fire Sciences Proposal submitted with the U.S. Forest Service, Mississippi State University, Louisiana Tech University, and Stephen F. Austin State University. The NATR ecologist is serving as an informal cooperator on a proposal to conduct a survey in three states concerning land management practices of non-industrial private landowners.

Adaptive Management

The primary process for providing feedback to park managers, regional prescribed fire specialist, and fire use module leaders is through the annual reporting of monitoring results. Results are discussed with park personnel as appropriate. Although current sample sizes preclude managers from making definitive adaptive management changes, current trends in the data reflect positive changes associated with prescribed fire.

Publications

Lisa M. McInnis, Brian P. Oswald, Hans M. Williams, Kenneth W. Farrish, and Daniel R. Unger. 2004. Growth response of *Pinus taeda* L. to herbicide, prescribed fire, and fertilizer. *Forest Ecology and Management*. 199:231-242.

FIGURES

Gulf Islands National Seashore

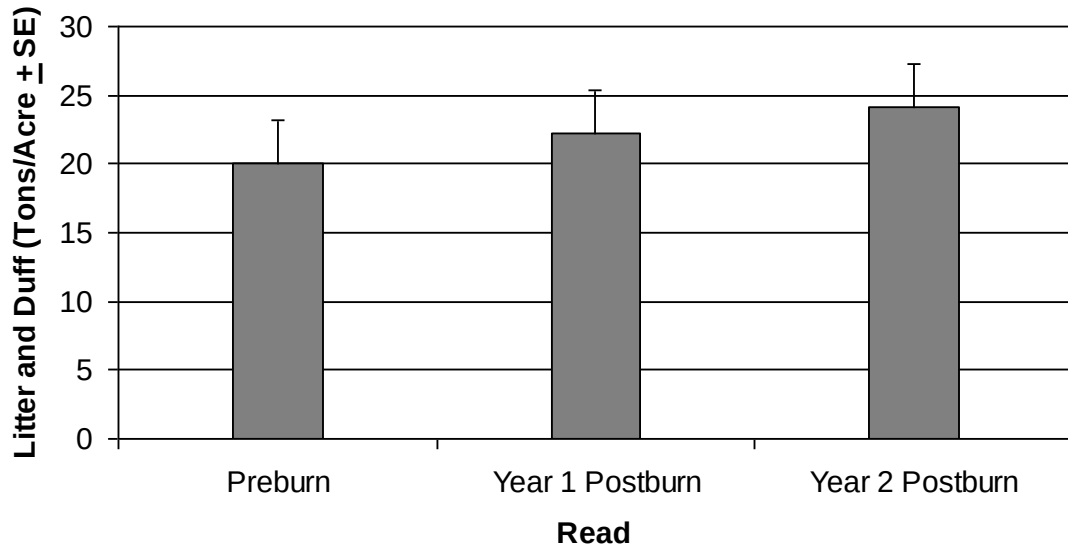


Figure 1. Average litter and duff loading for 5 *Pinus clausa* plots at GUIs ($\pm$ average standard error). Year 1 data was taken from 12-19 months postburn, while Year 2 data was taken 24-33 months postburn. Objective for litter and duff reduction is 20%; observed change was an increase of 20% by Year 2.

Gulf Islands National Seashore

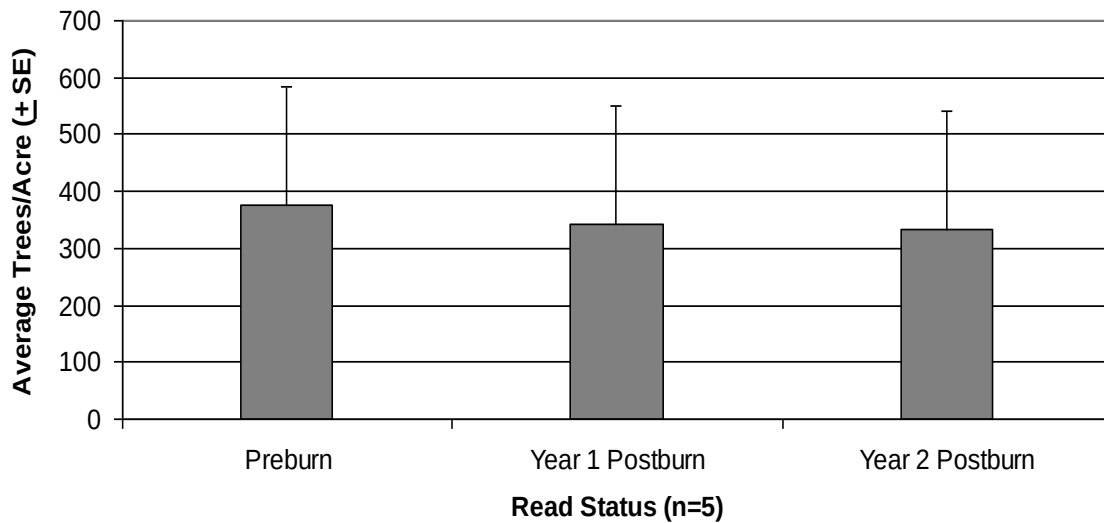


Figure 2. Average density of *Pinus clausa* trees per acre for 5 plots at GUIS ($\pm$ average standard error). Year 1 data was taken from 12-19 months postburn, while Year 2 data was taken 24-33 months postburn. Objective for pole reduction is 40%; actual reduction was approximately 11% by Year 2.

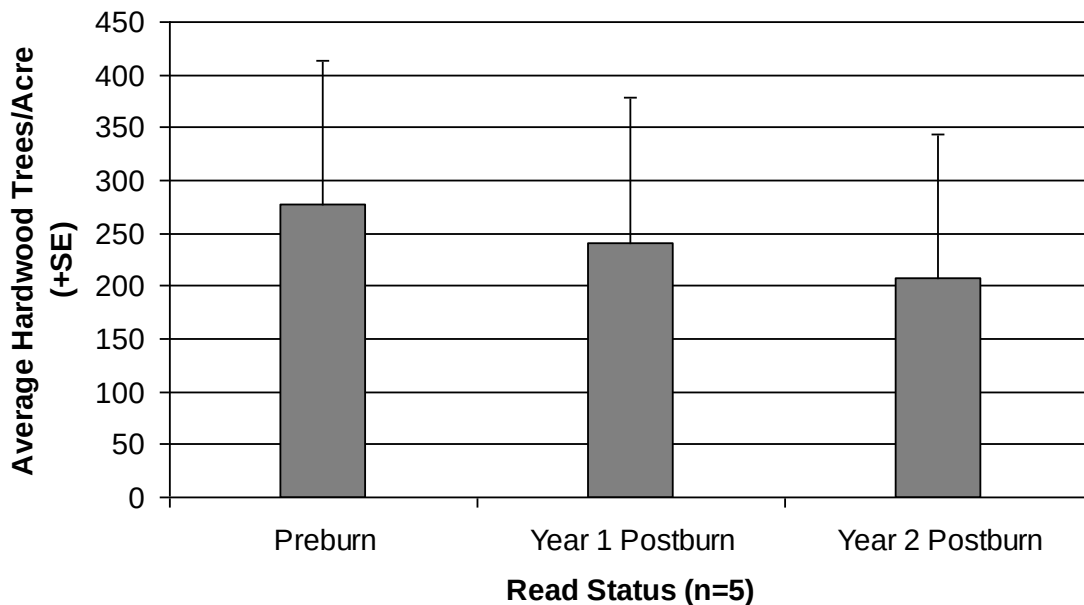


Figure 3. Average density of hardwood trees per acre for 5 *Pinus clausa* plots at GUIS ($\pm$ average standard error). Year 1 data was taken from 12-19 months postburn, while Year 2 data was taken 24-33 months postburn. Objective for pole reduction is 50%; actual reduction was approximately 25% by Year 2.

Gulf Islands National Seashore

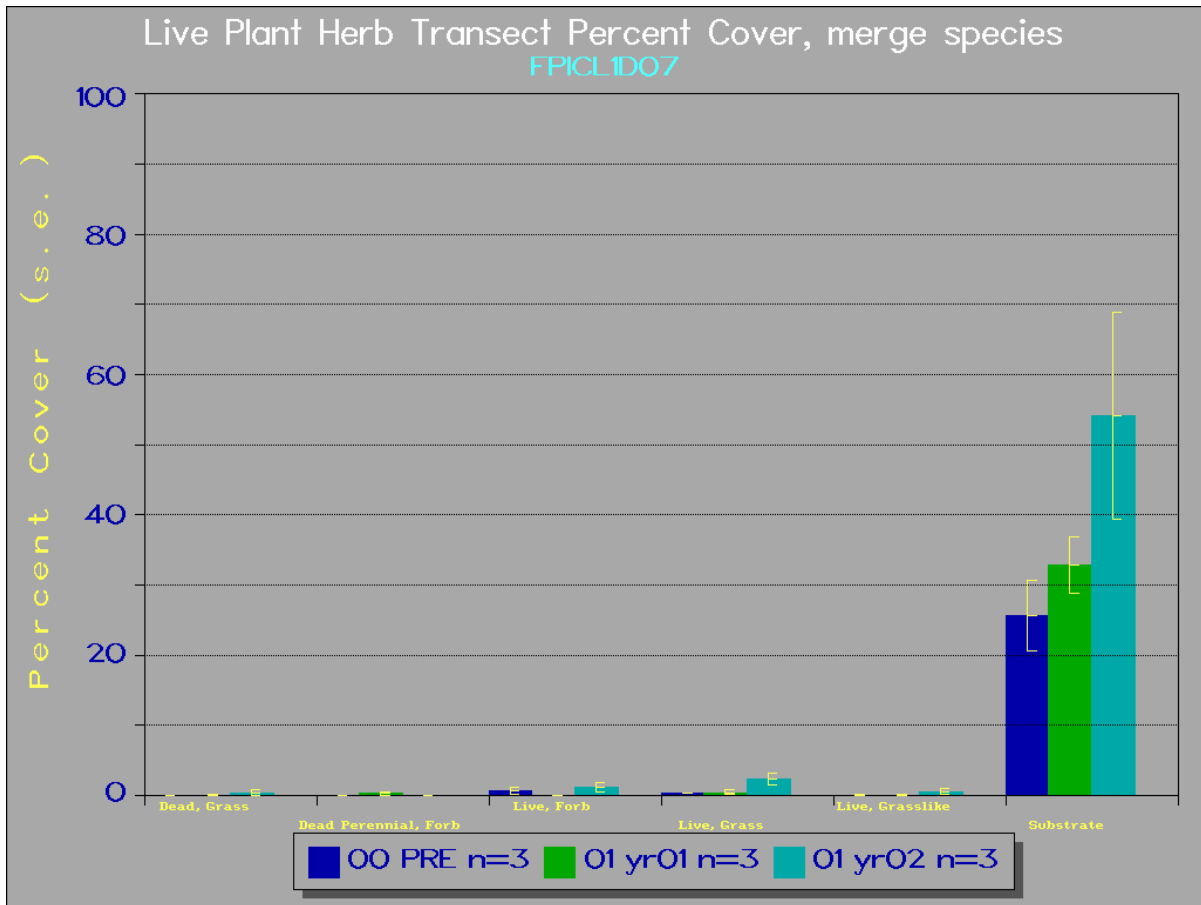


Figure 4. Average percent cover of herbaceous species (lumped by lifeform) for 3 *Pinus clausa* plots at GUIs ($\pm$ average standard error). Objective for herbaceous cover is a 20% increase; actual increase was approximately 23% by Year 2.

Gulf Islands National Seashore

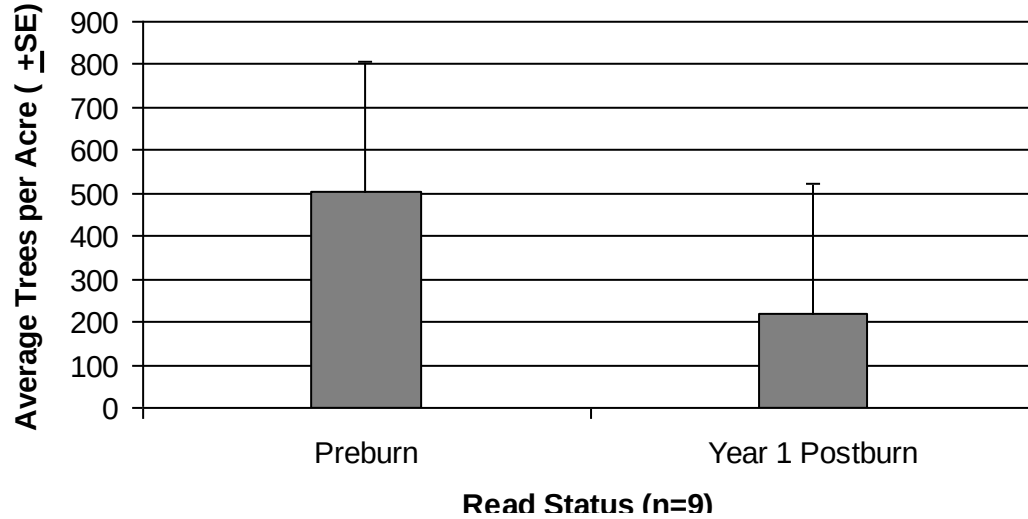


Figure 5. Average density of hardwood trees per acre for 9 *Pinus palustris* plots at GUIs ($\pm$ average standard error). Year 1 data was taken from 12-18 months postburn. Objective for pole reduction is 50%; actual reduction was approximately 56% by Year 1.

Gulf Islands National Seashore

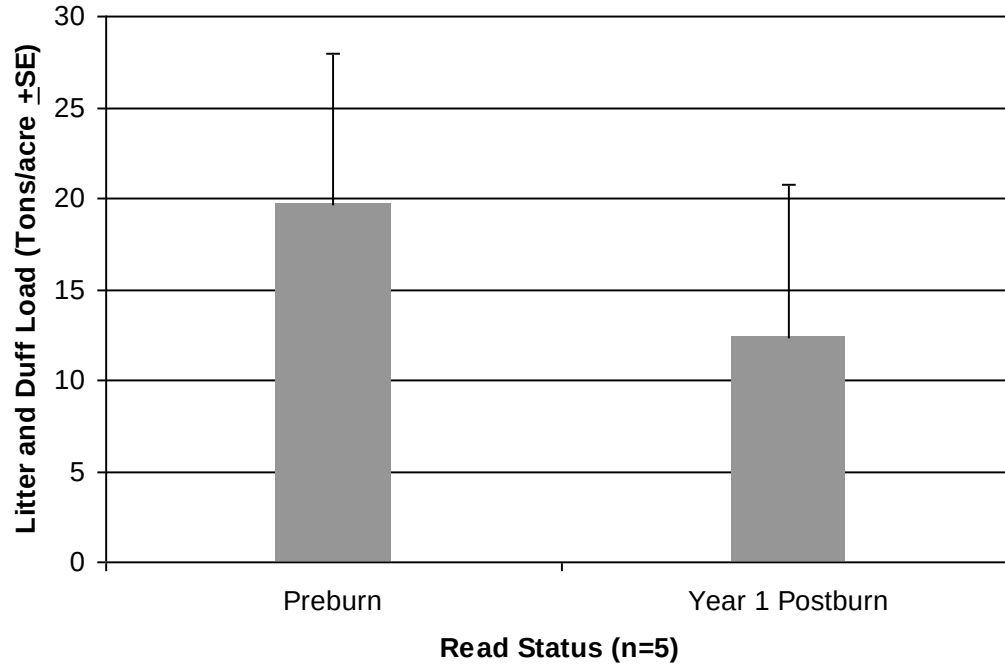


Figure 6. Average litter and duff load for 5 *Pinus palustris* plots at GUIs ($\pm$ average standard error). Year 1 data was taken from 12-18 months postburn. Objective for litter and duff reduction is 20-40%; actual reduction was approximately 37% by Year 1.

Gulf Islands National Seashore

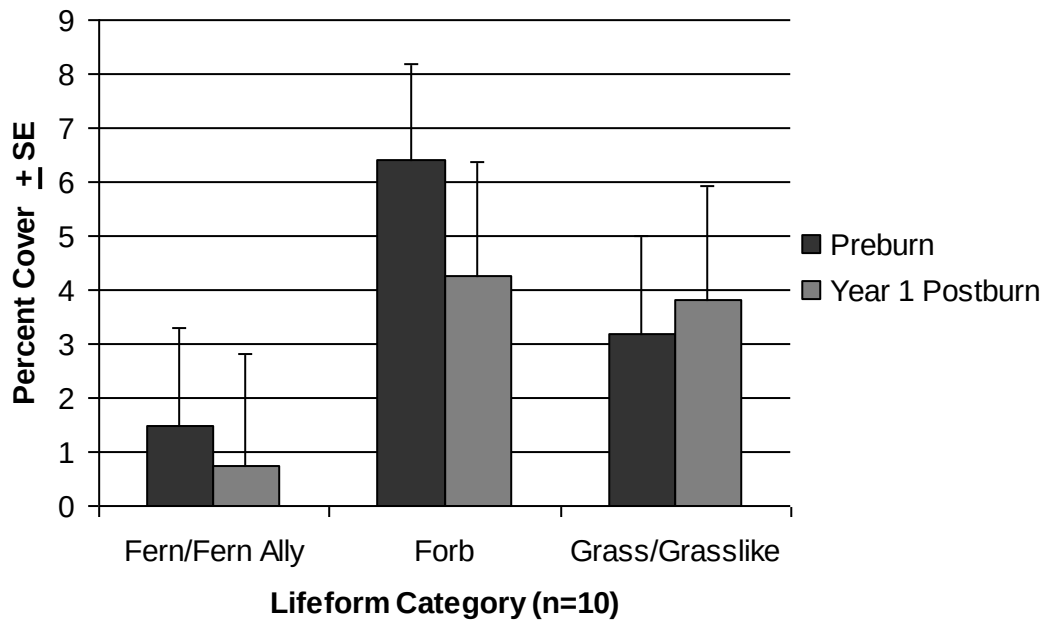


Figure 7. Mean percent cover $\pm$ SE of herbaceous species (lumped by lifeform) on 10 *Pinus palustris* plots at GUIs. Data was taken from 12-18 months postburn. Objective for herbaceous cover increase is 20%; observed change for ferns, forbs and grasses was a 21% decrease. Note increase in cover of grass/grasslike species.

Gulf Islands National Seashore

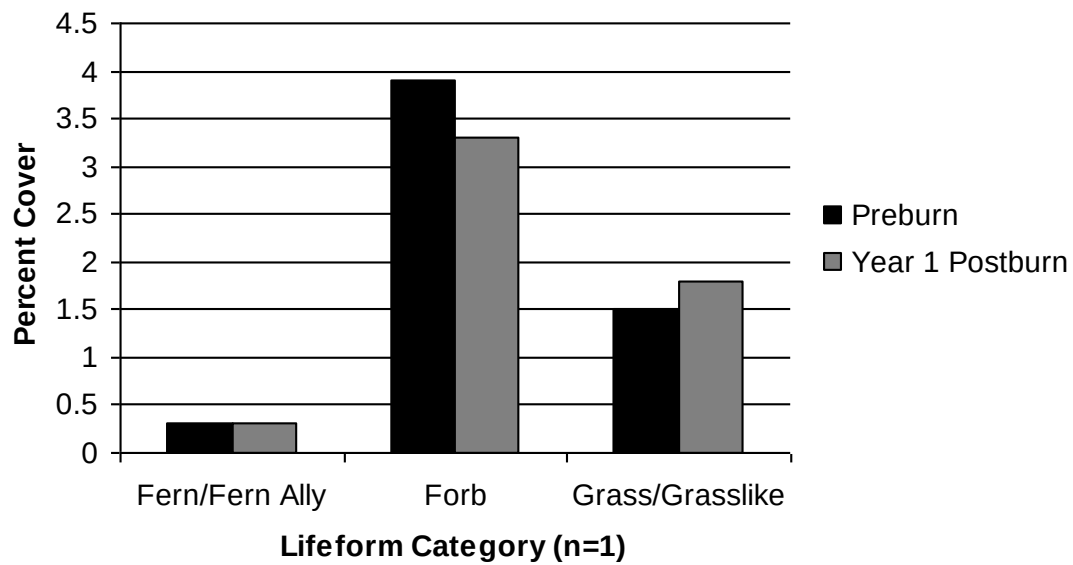


Figure 8. Percent cover + SE of herbaceous species (lumped by lifeform) on 1 *Sarracenia alata* plot at GUIs. Data was taken from 19 months postburn. Objective for herbaceous cover increase is 20%; observed change for ferns, forbs and grasses was a 5% decrease; however, season of postburn read did not coincide with season of preburn read. Note increase for grass/grasslike species percent cover. Standard error was not calculated because data from only one plot is represented.

Gulf Islands National Seashore

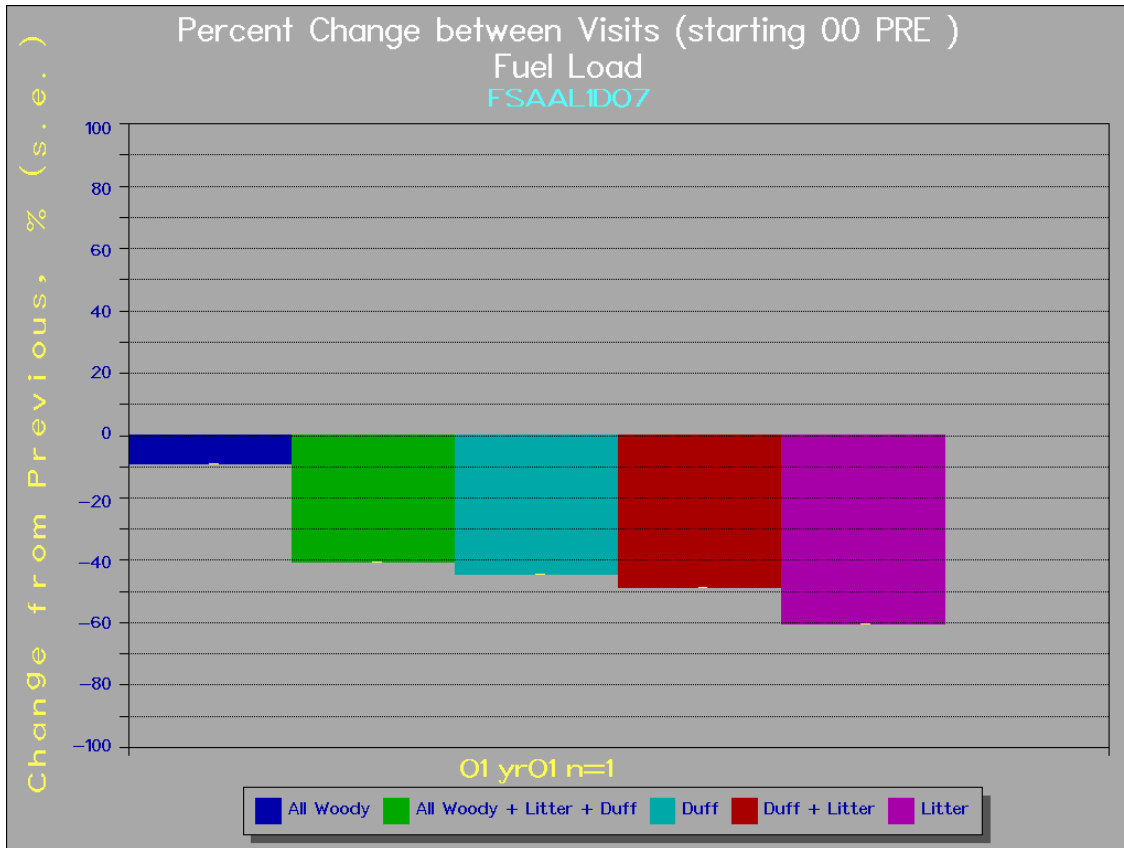


Figure 9. Total fuel load reduction on one *Sarracenia alata* plot at GUIs. Average reduction for litter and duff was 49%, and the minimum reduction objective was 20%. Standard error was not calculated because data from only one plot is represented.

Little River Canyon National Preserve

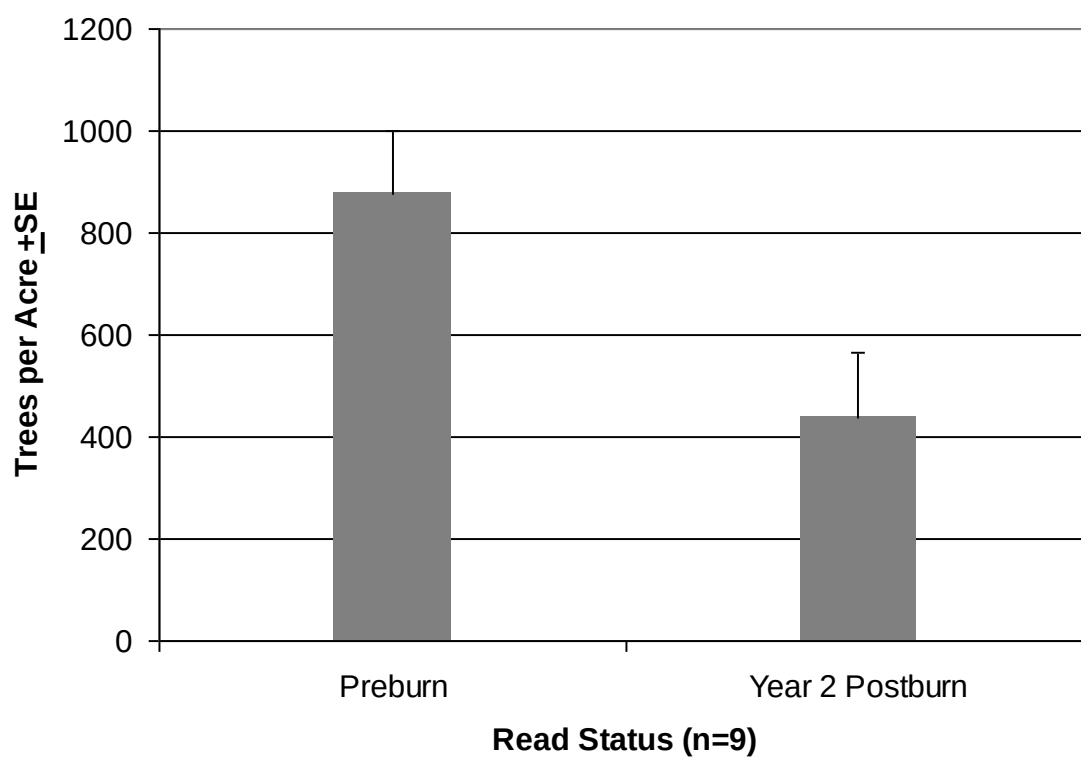


Figure 10. Average density of pole trees per acre for 9 *Pinus echinata* plots at LIRI ($\pm$ average standard error). Year 2 data was taken from 24-27 months postburn. Objective for pole reduction is 25%; actual reduction was approximately 50% by Year 2.

Little River Canyon National Preserve

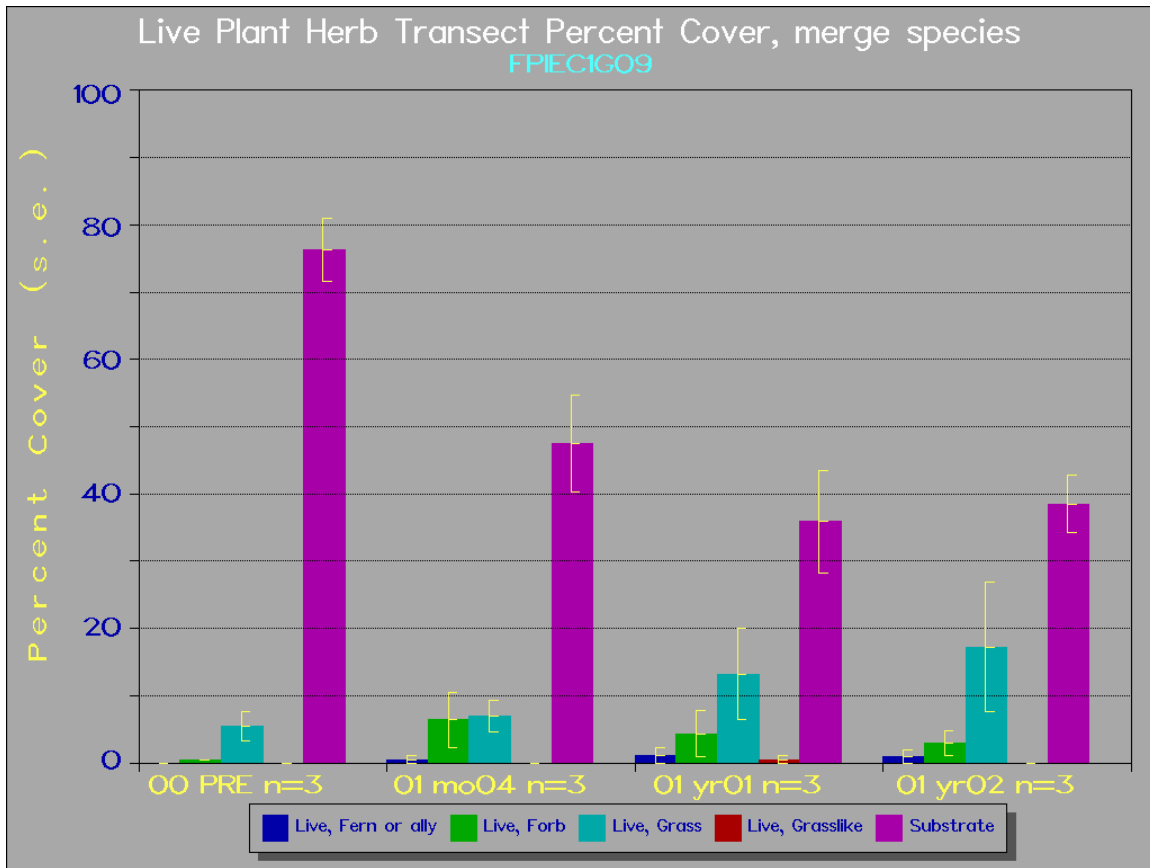


Figure 11. Herbaceous cover change LIRI ($\pm$ average standard error) on 3 *Pinus echinata* plots at LIRI. Average increase was 42%, while objective was 25% increase.

Little River Canyon National Preserve

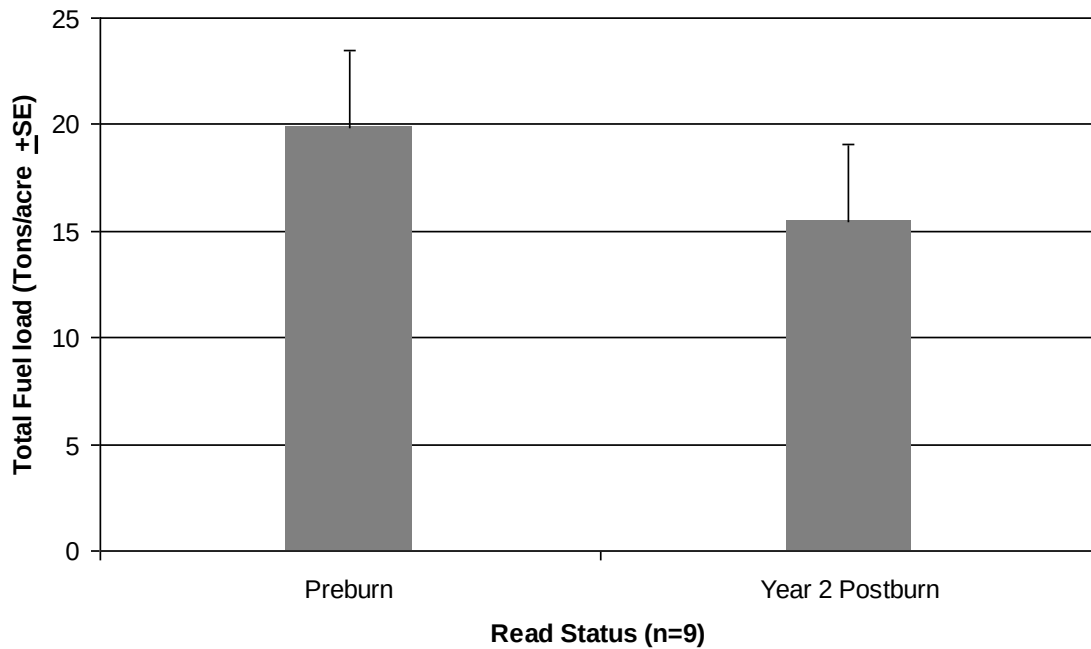


Figure 12. Average total fuel load in tons per acre for 9 *Pinus echinata* plots at LIRI ($\pm$ average standard error). Year 2 data was taken from 24-27 months postburn. Objective for fuel reduction is 25%; actual reduction was approximately 22% by Year 2.

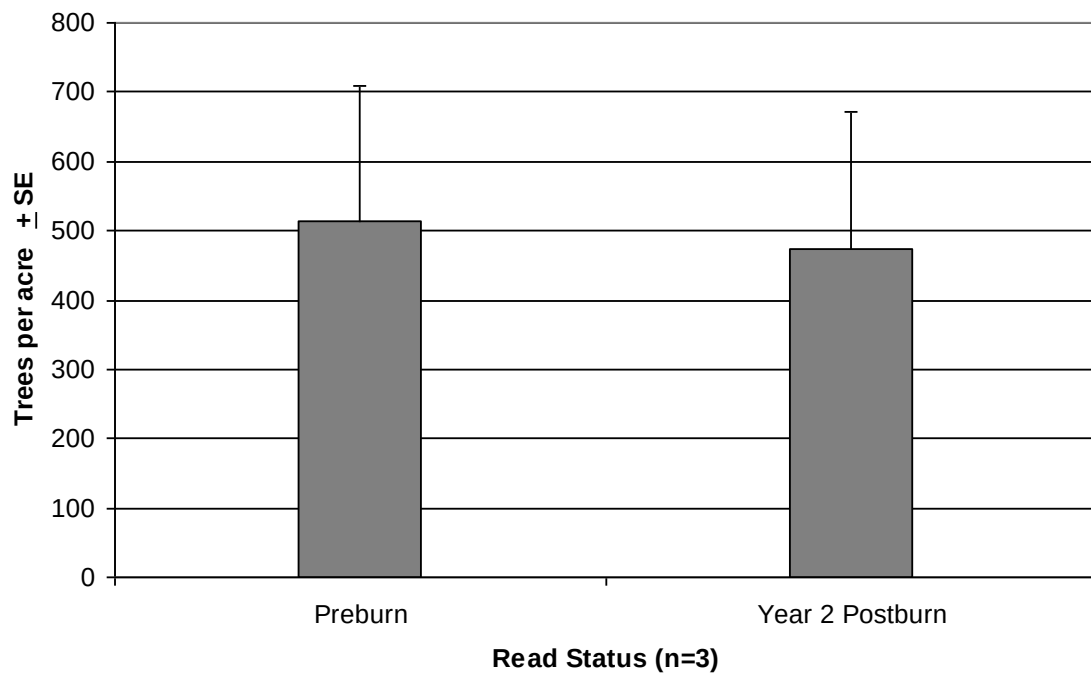


Figure 13. Average density of pole-sized trees per acre for 3 *Sarracenia oreophila* plots at LIRI ($\pm$ average standard error). Year 2 data was taken 26 months postburn. Objective for pole reduction is 30%; actual reduction was approximately 7% by Year 2.

Little River Canyon National Preserve

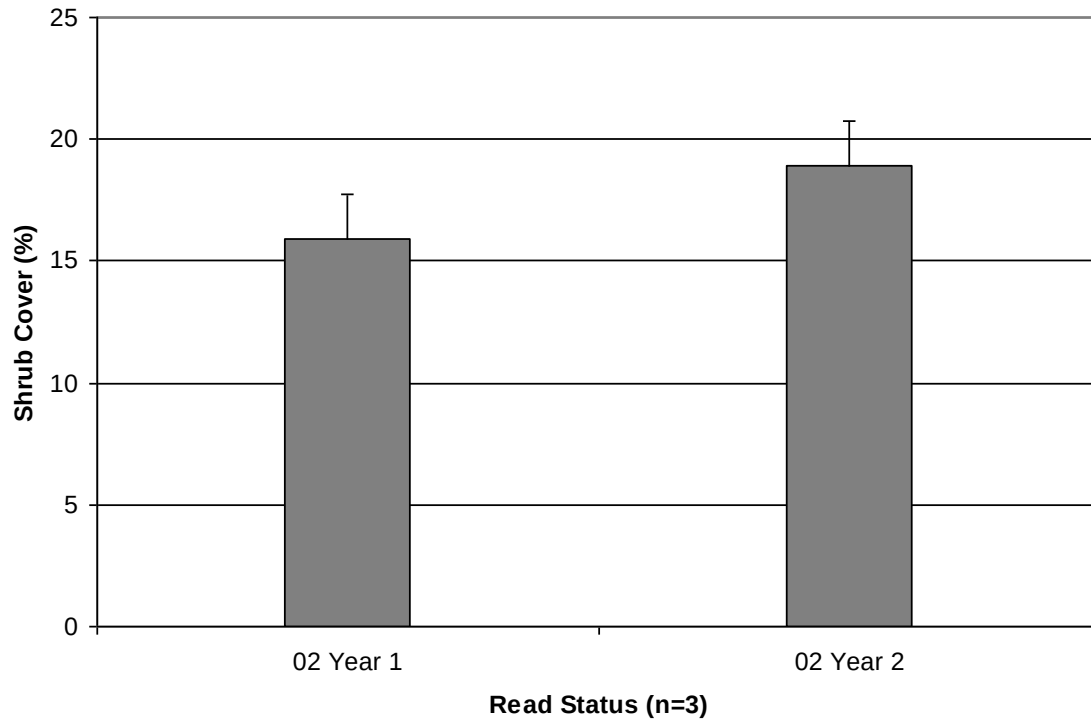


Figure 14. Average shrub cover for 3 *Sarracenia oreophila* plots at LIRI ($\pm$ average standard error). Data shown compares shrub cover collected at one and two years after the second fire. Objective for shrub reduction is 30%; actual change was an increase of 19% by Year 2.

Little River Canyon National Preserve

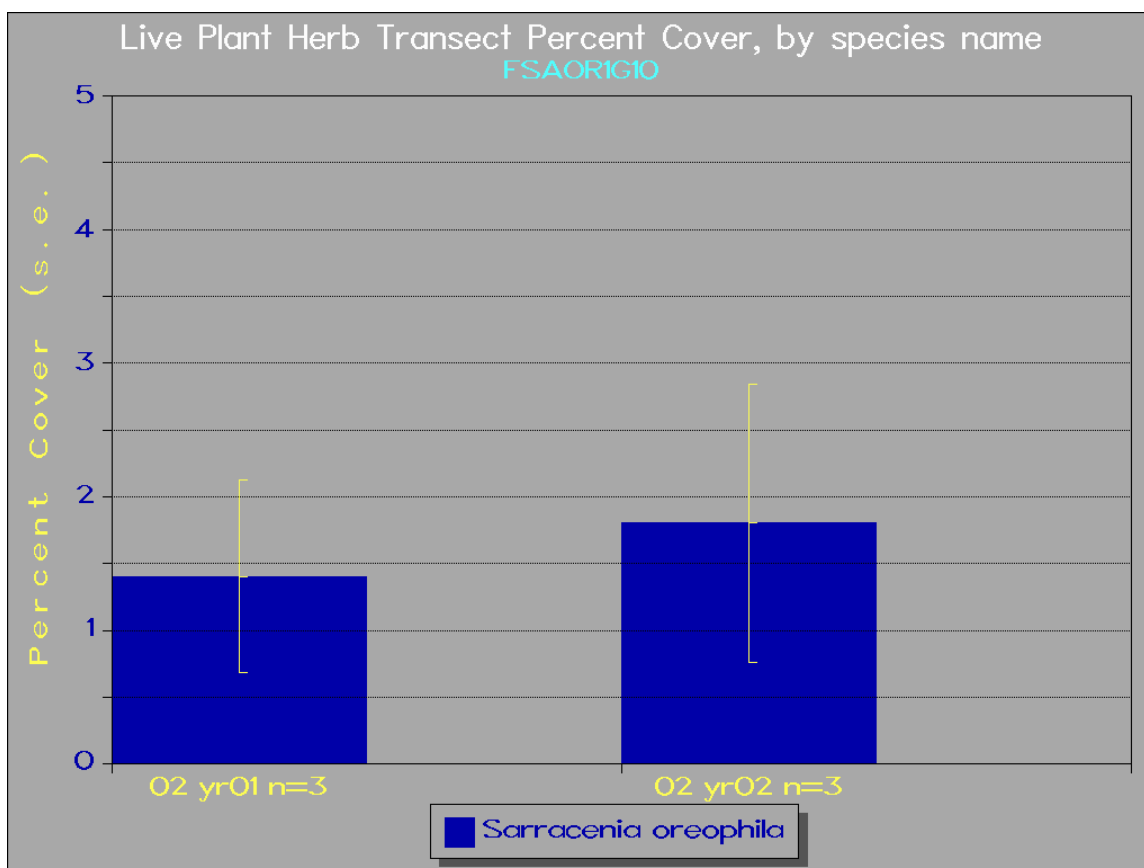


Figure 15. Average cover of *Sarracenia oreophila* on 3 plots at LIRI ($\pm$ average standard error). Data shown compares cover collected at one and two years after the second fire. Objective for cover increase is 20%; actual change was an increase of 28% by Year 2.

Little River Canyon National Preserve

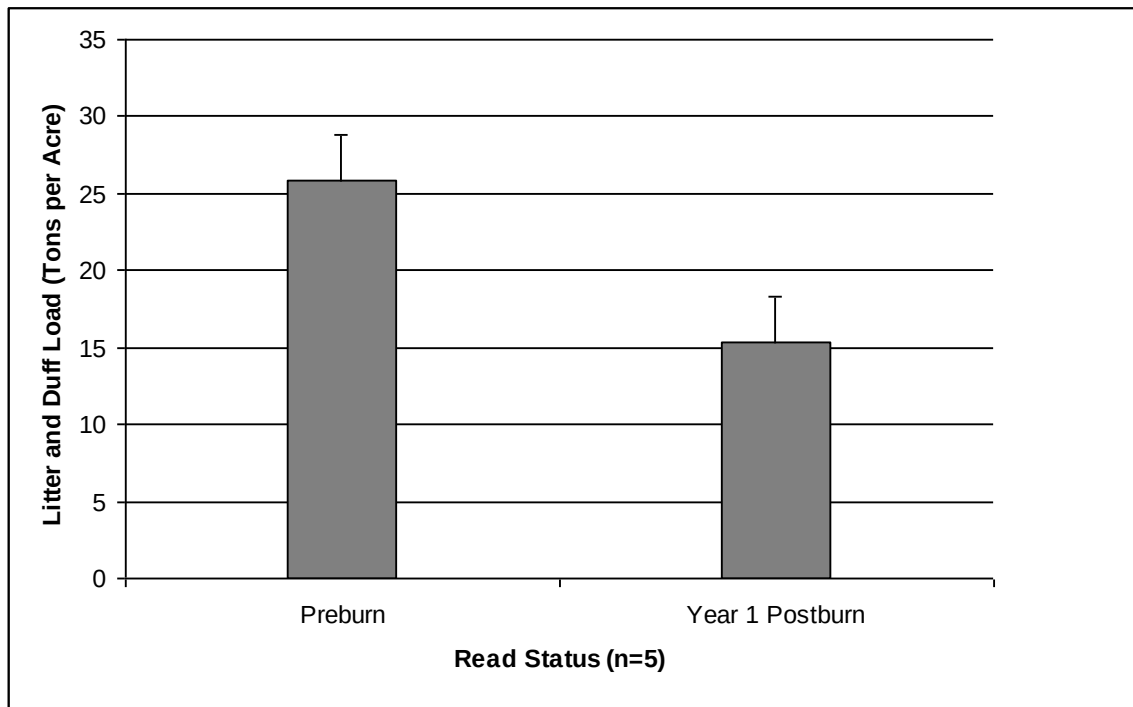


Figure 16. Average litter and duff in tons per acre for 6 *Sarracenia oreophila* plots at LIRI ($\pm$ average standard error). Year 2 data was taken 26 months postburn. Objective for fuel reduction is 25%; actual reduction was approximately 40% by Year 2.

Little River Canyon National Preserve

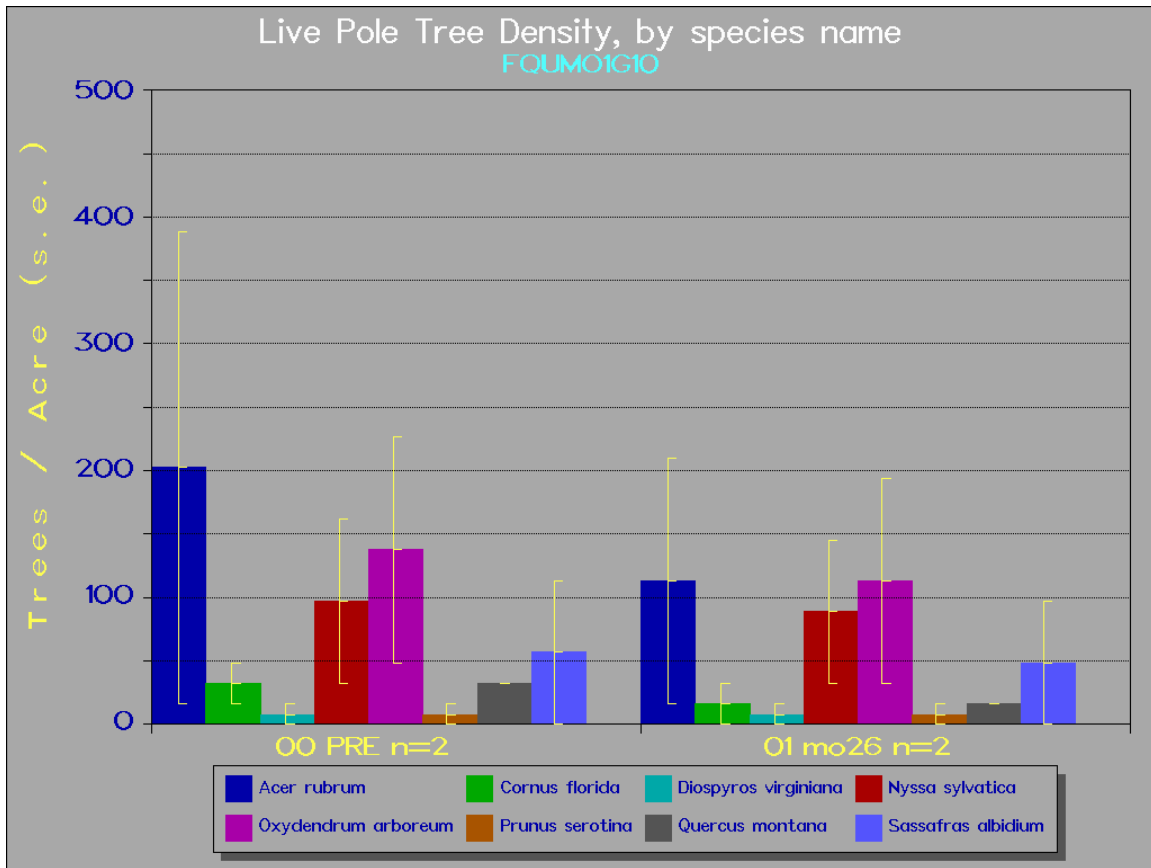


Figure 17. Average density of pole-sized trees per acre for 2 *Quercus montana* plots at LIRI ($\pm$ average standard error). Year 2 data was taken 26 months postburn. Objective for pole reduction is 20%; actual reduction was approximately 28% by Year 2.

Little River Canyon National Preserve

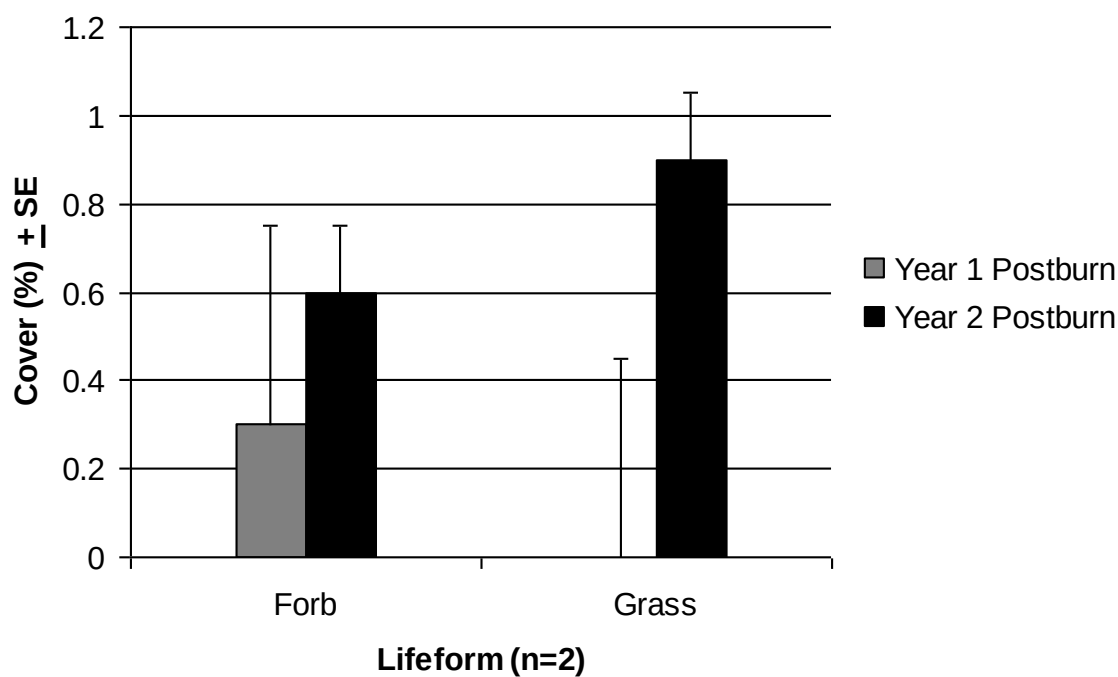


Figure 18. Mean percent cover $\pm$ SE of native grasses and forbs on 2 *Quercus montana* plots at LIRI. Data was taken 16 and 26 months postburn. Objective for herbaceous cover increase is 25% from preburn levels; observed change for forbs was 50%. No preburn data is available.

Little River Canyon National Preserve

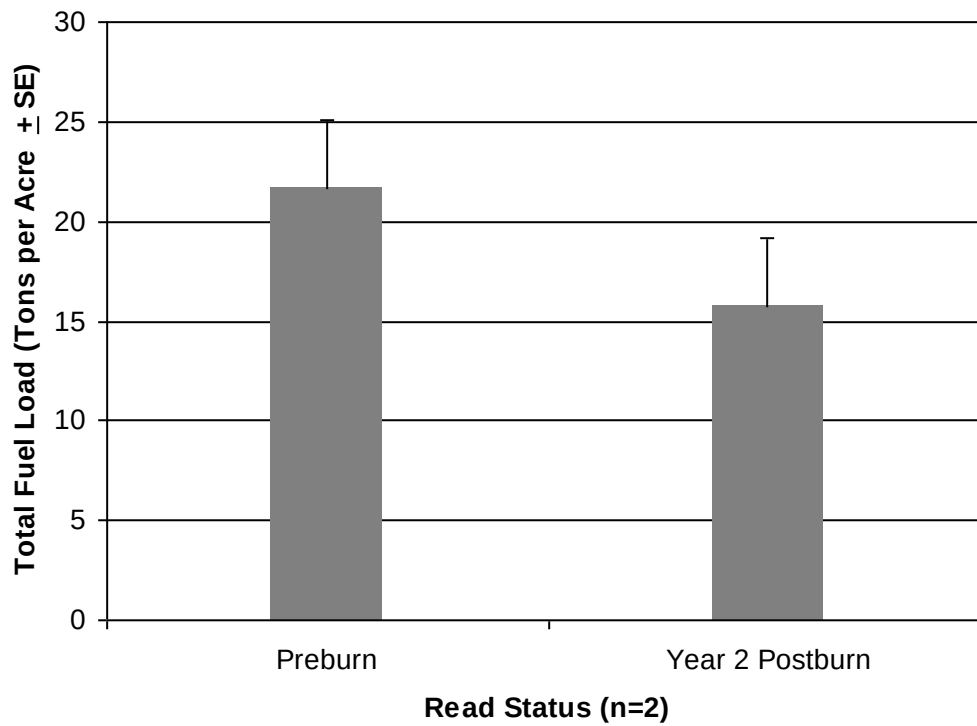


Figure 19. Mean total fuel load $\pm$ SE on 2 *Quercus montana* plots at LIRI. Data was taken 26 months postburn. Objective for fuel load reduction is 25% from preburn levels; observed reduction was 27%.

Mammoth Cave National Park

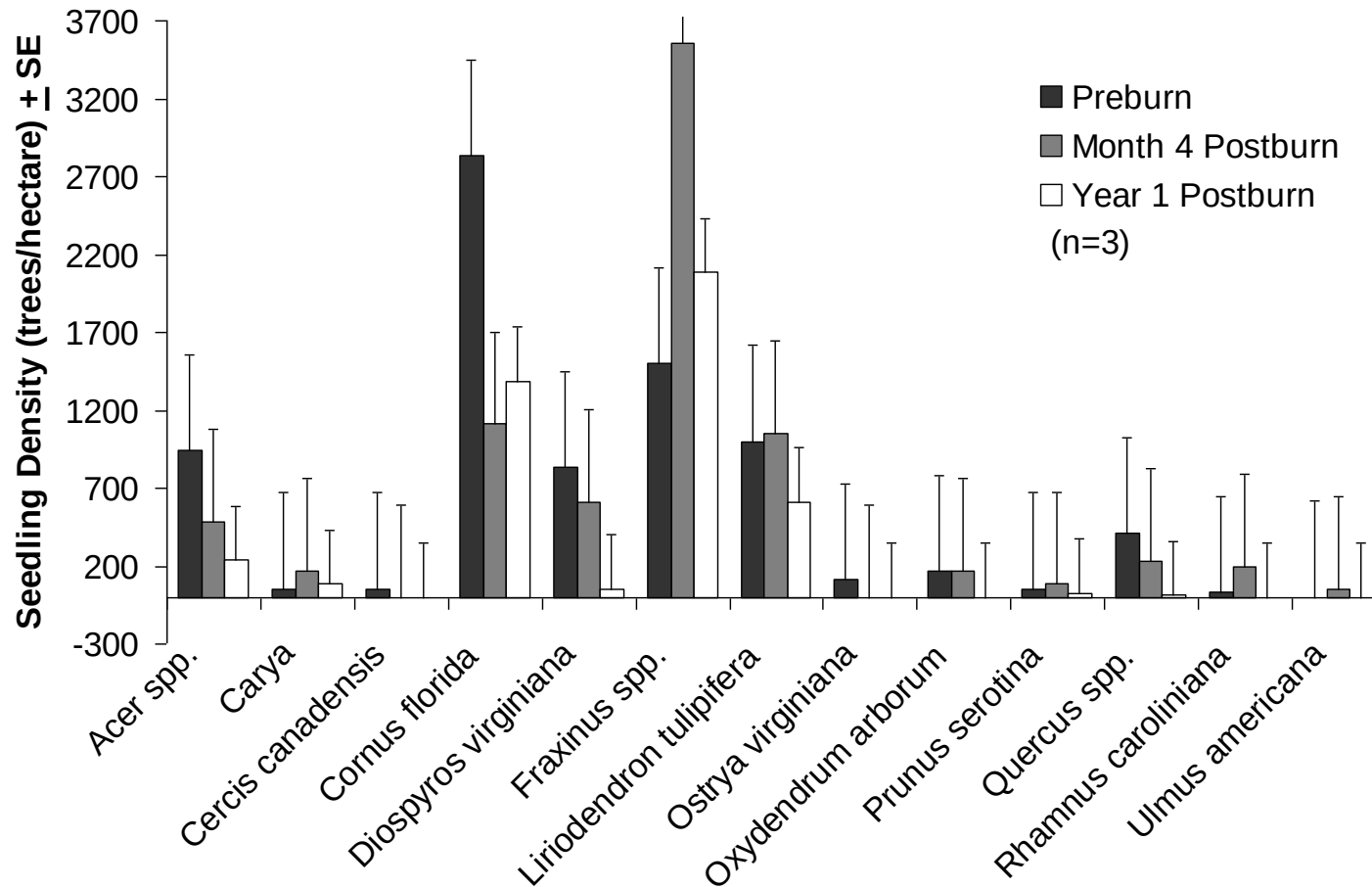


Figure 20. Average density of 13 shade-tolerant seedling species on 3 *Sorghastrum nutans* transects at MACA ($\pm$ average standard error). Data shown compares shrub cover collected at one and two years after the second fire. Objective for seedling reduction is 30%; actual change was a decrease of 47% by Year 1.

Mammoth Cave National Park

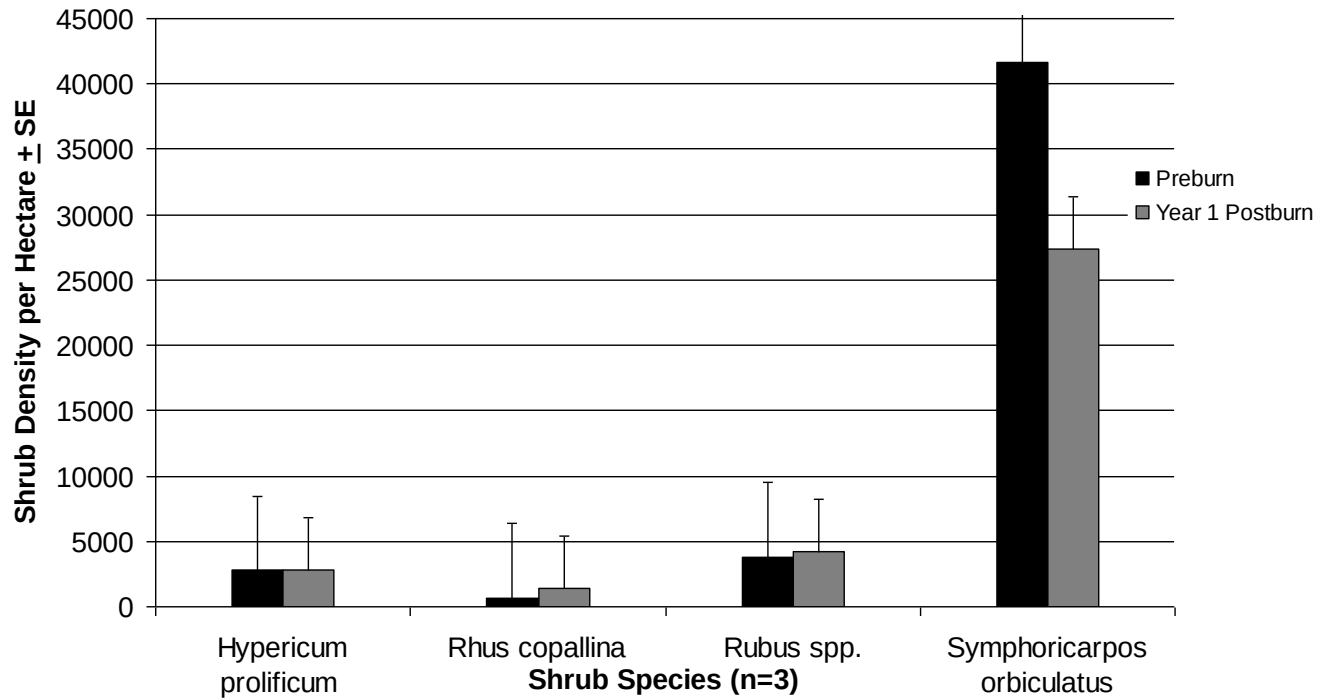


Figure 21. Average shrub density for 3 *Sorghastrum nutans* transects at MACA ($\pm$ average standard error). Data shown compares shrub density collected at one year postburn. Objective for shrub density reduction is 30-60%; actual decrease was 27%.

Mammoth Cave National Park

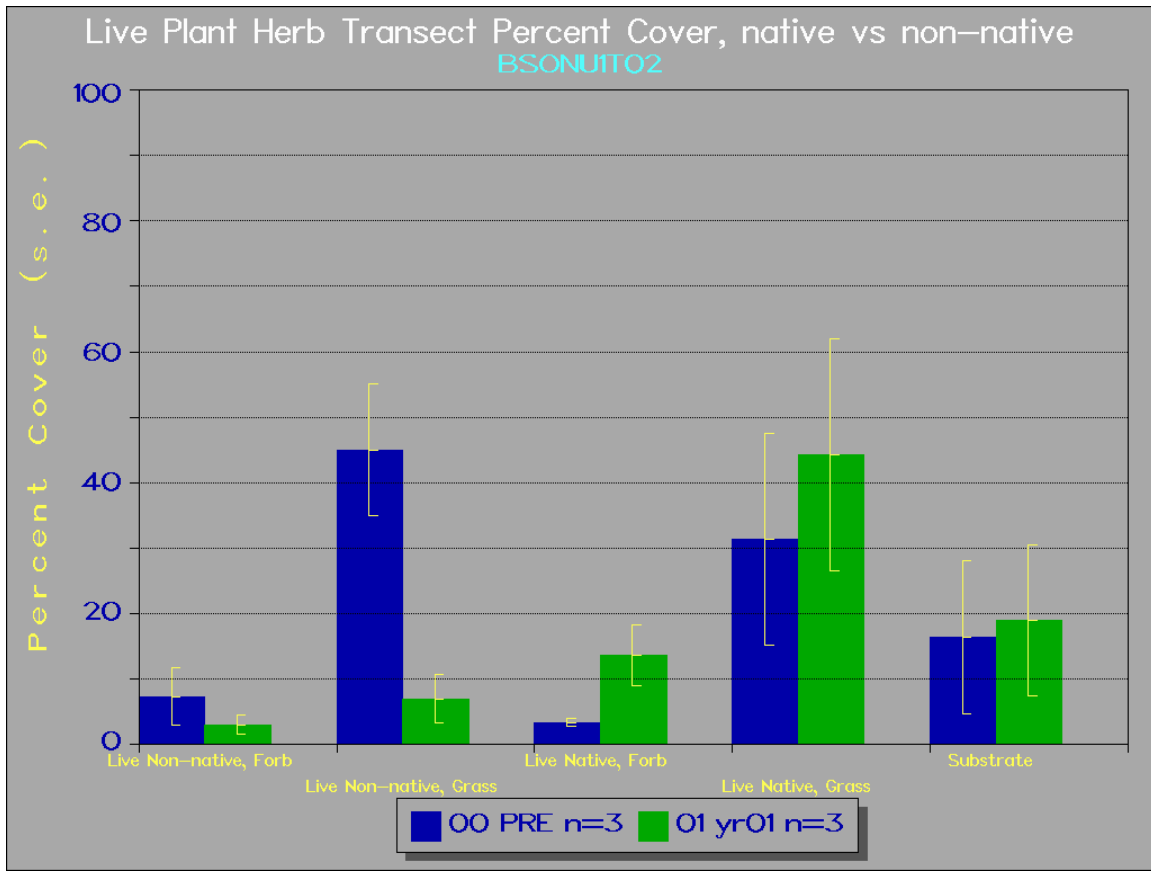


Figure 22. Percent cover of native versus non-native herbaceous species on 3 *Sorghastrum nutans* transects at MACA ($\pm$ average standard error). Data shown compares herbaceous cover collected preburn and at one year postburn. Objective is to cause no net gain in cover of non-species, and average reduction for non-native forb and grass cover was 71%.

Mammoth Cave National Park

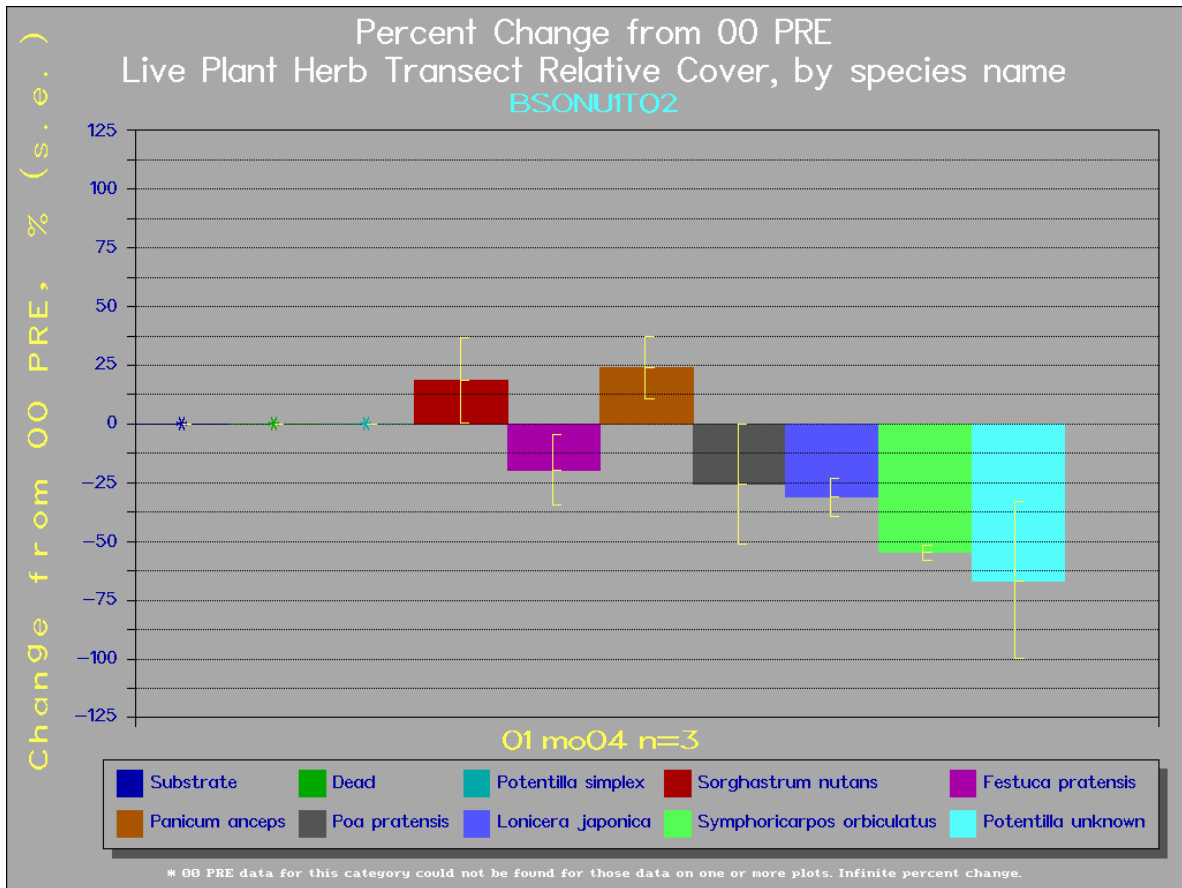


Figure 23. Increase in cover of *Sorghastrum nutans* $\pm$ SE (red bar) on three plots at MACA. Average increase in relative cover was 19%, and minimum objective increase was 15% after 5 years of burning.

Mammoth Cave National Park

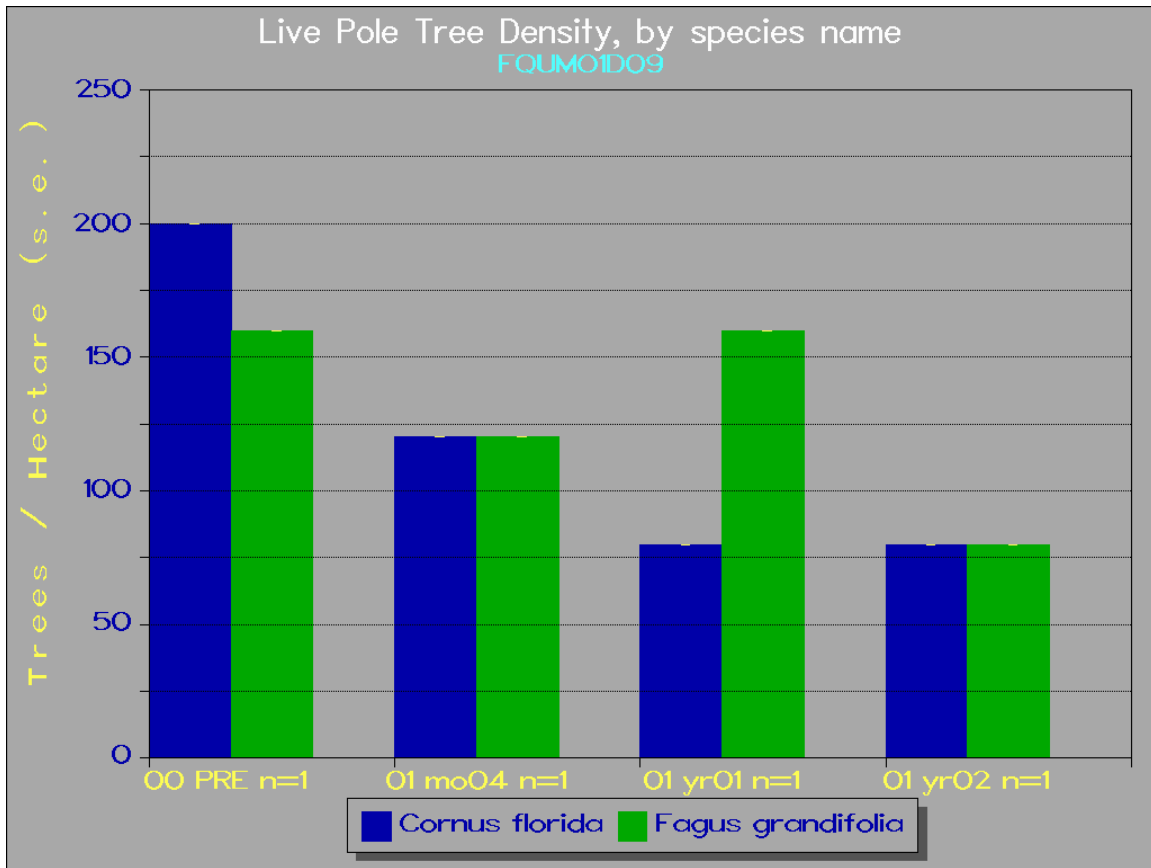


Figure 23. Average density of pole-sized trees per acre for 1 *Quercus montana* plot at MACA ($\pm$ average standard error). Data was collected 4 months, 1 year and 2 years postburn. Objective for pole reduction is 30-90%; actual reduction was approximately 55% by Year 2.

Mammoth Cave National Park

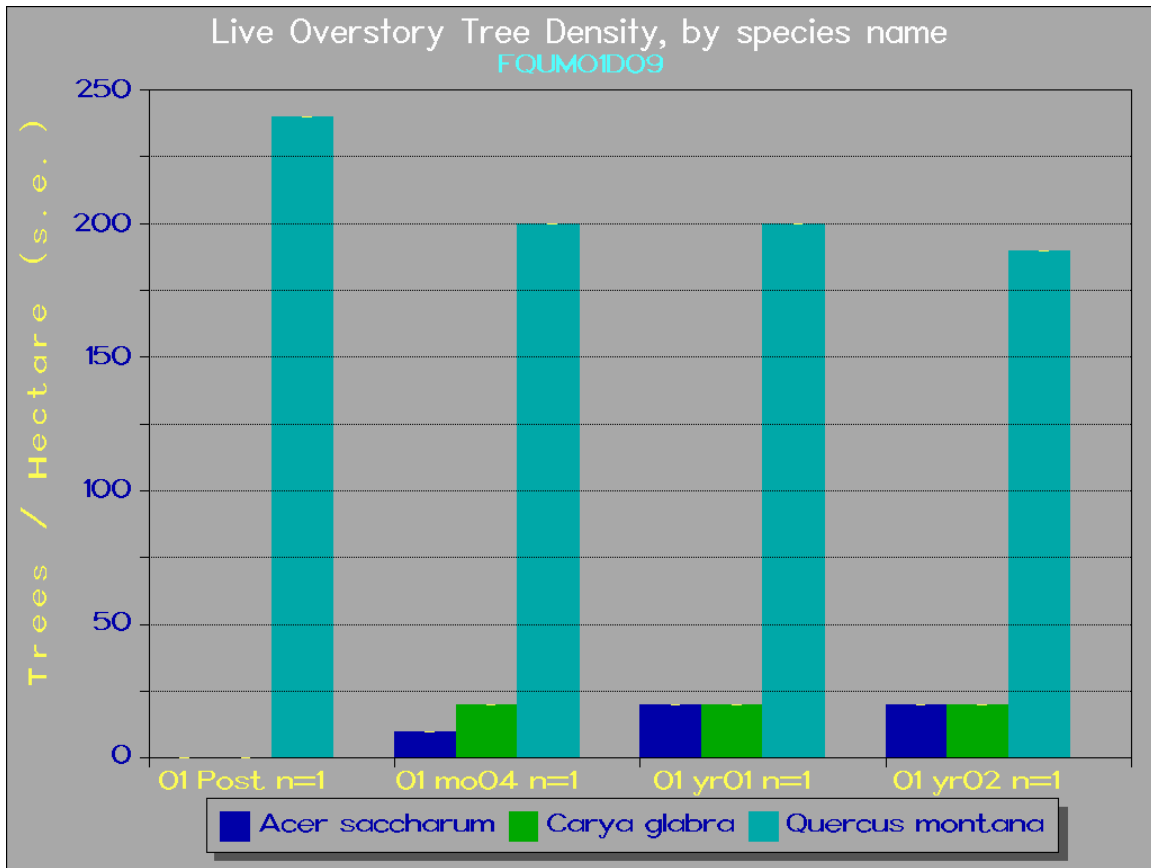


Figure 24. Average density of overstory trees per hectare for 1 *Quercus montana* plot at MACA ($\pm$ average standard error). Data was collected 4 months, 1 year and 2 years postburn. Objective for overstory mortality is 20% or less; actual reduction was approximately 4% by Year 2

Mammoth Cave National Park

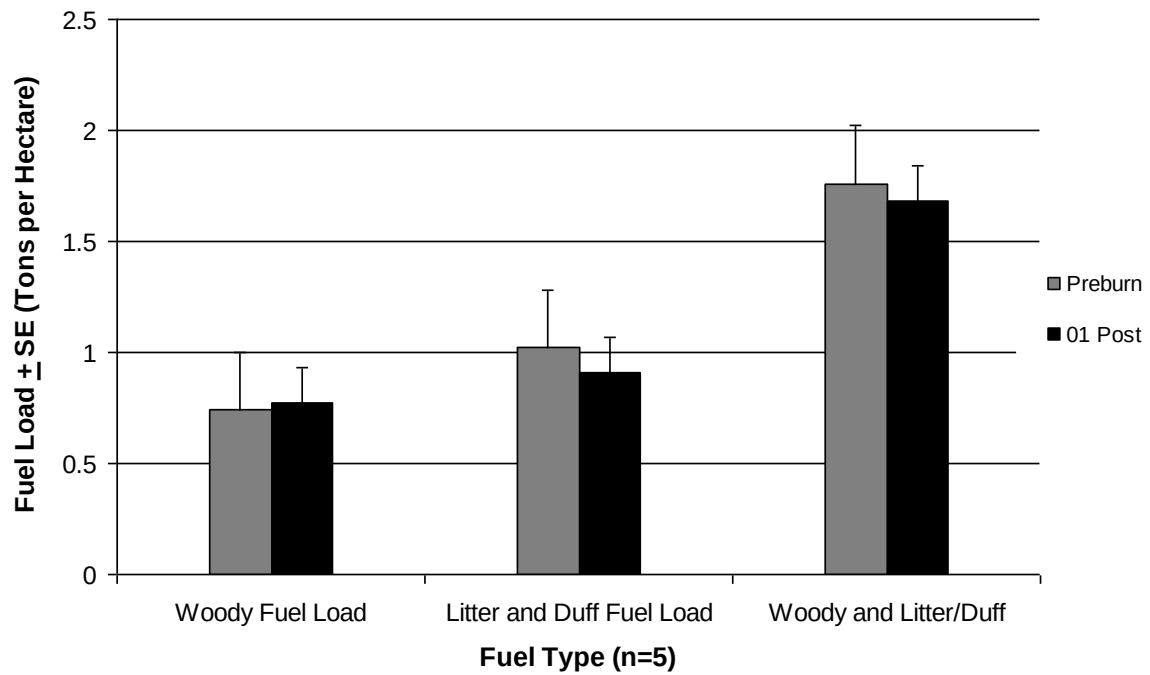


Figure 25. Fuel load for 5 *Juniperus virginiana* plots at MACA ($\pm$ SE). Objective for fuel load reduction was 25-50%, and observed reduction was 4% immediately postburn.

Natchez Trace Parkway

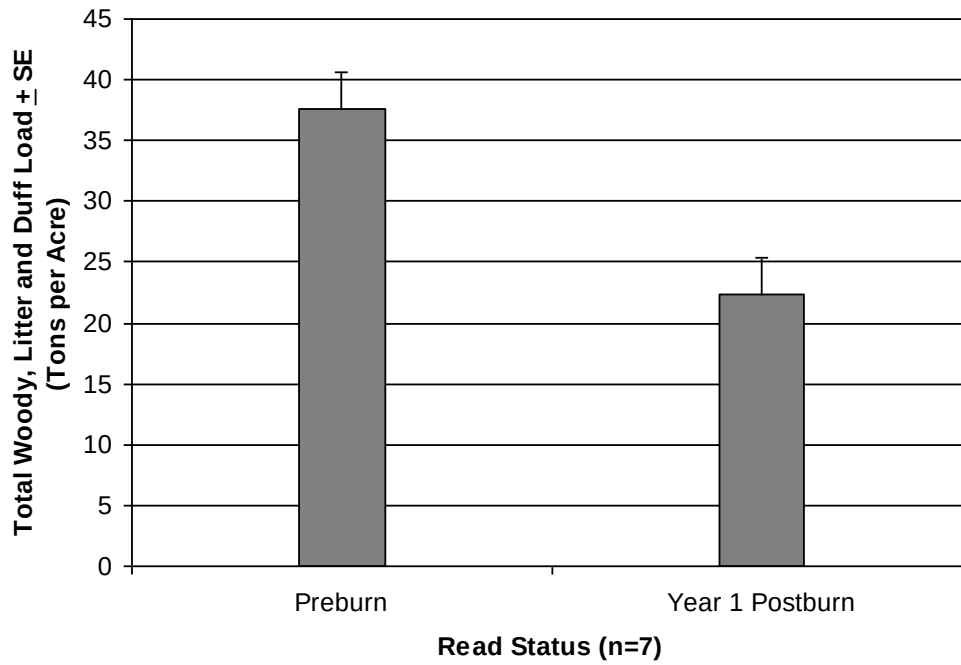


Figure 26. Total average fuel load for 7 *Pinus taeda* plots at NATR ($\pm$ SE). Postburn data was taken 14-15 months after the fire. Objective for fuel load reduction was 20-40%, and observed reduction was 40% by Year 1.

Natchez Trace Parkway

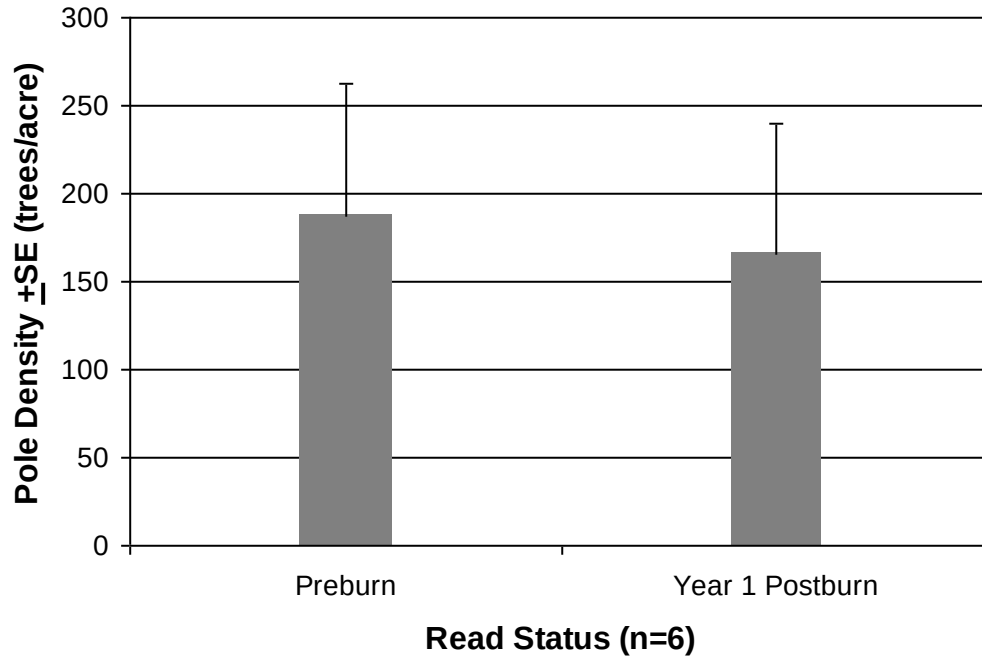


Figure 27. Total average pole density for 6 *Pinus taeda* plots at NATR ($\pm$ SE). Postburn data was taken 14-15 months after the fire. Objective for pole density reduction was 25%, and observed reduction was 12% by Year 1.

Natchez Trace Parkway

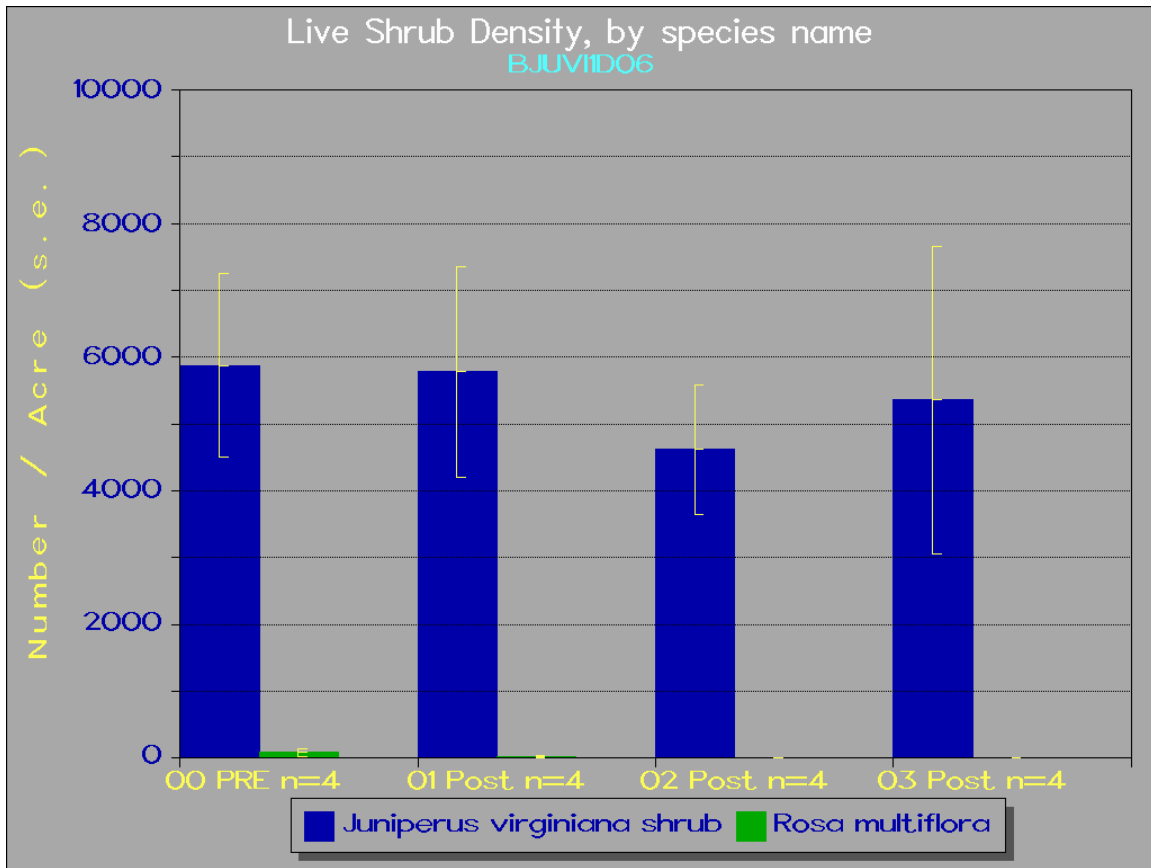


Figure 28. Average shrub density for 4 *Juniperus virginiana* plots at NATR ($\pm$ SE). Postburn data within 2 weeks of each of three fires (i.e. 01 Post, 02 Post, and 03 Post). Objective for shrub density reduction was 25%, and observed reduction was 9% after the 3rd fire.