



I. PROGRAM SUMMARY

The 2006 season was both diverse and productive for Grand Canyon National Park's (GRCA) Fire Ecology Program. While making 60 FMH plot visits, including 5 immediate post-burn reads, all scheduled work was completed with time available for training and contributing to the national firefighting effort. In addition, 137 CBI plots were installed within six fires at GRCA to allow assessment of burn severity. This monitoring workload marks the third busiest season in the program's 18-year history. Beyond monitoring, the Fire Ecology Program provided strategic support to the Fire Management Program with the Fire Ecologist serving as program lead for the development of the fire management plan EIS.

Advertising and filling a permanent, subject-to-furlough GS-6 Assistant Lead position with a returning employee was a huge benefit to the fire effects monitoring program.

For the first time, we had a field staff of two permanent and three seasonal employees, producing a lively and efficient work environment. Continuing to duty-station all but the Lead on the North Rim to reduce time lost to travel also facilitated our efforts. With the loss of our Fire Information, Prevention and Education Specialist position, the GRCA Fire Ecologist stepped up and completed valuable Information Officer duties for both in-park and out-of-park fire activities.

Crewmembers took part in a diverse array of extracurricular activities. We had a less fire-experienced crew, but used this as an opportunity to acquire more fire and aviation training for individuals than any previous year. Efforts continued in cross-training crewmembers with all other field disciplines in our fire management program, and personal interest by the crew greatly facilitated the multi-disciplinary learning. To spread the wealth of knowledge further, three other Grand Canyon fire personnel were cross-trained in fire effects plot monitoring protocols. We continued our long record of support to the fire management program by monitoring and documenting fire behavior and weather during all prescribed and fire use events. Due to the abbreviated season of the North Rim fire crew, and multiple out-of-park assignments for Engine 6-2, the Fire Effects crew provided more support to North Rim fire operations than ever before: road clearing, fuel sampling, and initial fire size-up responses were commonplace throughout the 2006 season.

Data analysis included updating fuel loading totals for the South Rim District FMO and Air Quality Specialist, querying the database to provide data for the Fire Management Plan EIS, and working on the annual report. Analyses for Zion's 2005 annual report and a poster for the FMO conference was also completed. Conversion of the GRCA database to FEAT v2.4 at the end of the field season continued, while FMH remained the working program used to enter, store, and analyze data. In conjunction with the Zion Fire Ecologist in January, and with the new Lead Monitor at Zion in November, the GRCA Lead Monitor lead conversion of FMH databases to FEAT v2.4 for all the parks in the Utah Network (Zion, Bryce Canyon, Arches, and Golden Spike) during two details to Zion National Park at the beginning and end of 2006.

Out-of-park, the Assistant Lead completed one Helicopter Crewmember (HECM) assignment to the Derby Fire in Montana. Continuing a six-year tradition of assisting other Fire Effects Monitoring programs, two crewmembers detailed with the Saguaro and Yellowstone crews. Unfortunately, we were not able to detail anyone out-of-park with Fire Use Modules, but did get multiple crewmembers experience in-park with the Zion Module.

Family emergencies and personal commitments pulled crew members away from work on occasion. Normally it would be difficult to accomplish this quantity of work with the crew gone 10% of the time, but the efficient use of personnel when they were present, the balancing of fire assignments, and the return to a 5-person crew allowed us to meet our goals.

II. STAFF ACCOMPLISHMENTS & AREAS OF FOCUS

Table 1. Fire Ecology Staff for 2006 calendar year.

Employee	Starting Date	Ending Date	# Pay Periods	Training	NWGG Taskbooks
Mary Rasmussen, GS-11	01/01/06	12/31/06	26	S260 S270	PIO2
Li Brannfors, GS-7	01/08/06 04/30/06	03/18/06 12/16/06	5 16.5		FFT1-t ICT5-t
Missy Spandl, GS-6	04/30/06	12/09/06	16	S212	FALA-t
Frank Wallander, GS-5	04/30/06	10/28/06	13	S290 S271 S212	FEMO-t HECM-t FALA-t
Jay Lininger, GS-5	05/14/06	10/28/06	12	S271 HTA S131 S211	FEMO-t HECM-t FFT1-t FALA-t
Carrie Minerich, GS-5	05/14/06	10/14/06	11	S271 HTA S290 S131 S212	HECM FEMO-t FFT1-t FALA-t

Table 2. Base-hour Fire Effects crew activities by percent and category. Highlighted areas are where crewmembers spent majority of base-hour time.

Employee	FMH Plots	CBI Plots	Data Entry	Data Analysis	FX Office	Monitoring (Rx or Fire Use)	Rx Fire Ops	Fire Use Ops	Suppression And Helibase Ops.	Training Courses	Other
Li Brannfors, GS-7	17	5	4	7	47	3	2	0	1	1	13
Missy Spandl, GS-6	20	5	5	1	32	9	1	0	8	4	15
Frank Wallander, GS-5	27	10	5	0	17	3	0	0	8	12	18
Jay Lininger, GS-5	26	3	6	0	17	6	2	1	11	11	17
Carrie Minerich, GS-5	20	4	1	0	18	11	4	3	10	13	16

"FX Office" includes miscellaneous plot data preparation and management time, photo filing, paperwork, supervision, PT time, etc.

"Other" includes meetings, paid holidays off, air quality, non-fire duties, leave taken, etc.

Table 3. Fire Effects Crew Focus Areas/Accomplishments 2006

Focus Area	Percent Time	Notes
FMH Plots	21%	• 50 remeasurements, 5 immediate post-burn reads, 5 installs • Detailed crewmembers to assist Saguaro & Yellowstone programs
CBI Plots	5%	• 137 plots across 6 fires • Trained Zion crew in CBI field protocols at GRCA N Rim • Trained Zion Ecologist in CBI/NBR GIS protocols at GRCA N Rim
Data Entry	3%	• Completed all 2006 FMH & CBI plot data entry by Nov. 7
Data Conversion	2%	• Lead & Assistant Lead converted GRCA FMH data to FEAT in Dec. • Detailed Lead to Zion to assist conversion in Jan. & Nov.
Data Analysis	2%	• 2006 Annual Report analysis on all major variables in program • Comparison of Rx vs. WFU fuel load and tree density numbers • Fuel load numbers for whole program to date • Fuel load numbers for Walla Valley Burn Plan by S Rim District FMO • Fuel load numbers for FOFEM runs by Air Quality Specialist • Cleartrap Rx analysis for Zion Ecologist & FMO conference poster • 2005 Annual Report analysis for Zion Ecologist
General Office/ Supervision/ Admin	30%	• Includes FMH & CBI plot preparation and data filing/organization • Downloaded & cataloged all plot photos digitally for first time • Developed new digital photo downloading & printing guide • Lead hired 3 seasonal crewmembers • Lead supervised 1 permanent Assistant Lead, 3 seasonals • 1 hr. PT time/day for each crewmember • Paperwork!
Fire Monitoring (Rx or WFU)	6%	• Lead FEMO & FEMO-trainees on all 4 Rx fires at GRCA • Lead FEMO & FEMO-trainees on 7 WFU fires at GRCA
Fire Operations/ Assignments (Suppression, Rx, WFU, or Helitack)	9%	• Assistant Lead went on 2 week HECM assignment to MT • 1 crewmember detailed for 2 weeks to Yellowstone for multi-purpose Rx, WFU, fuel sampling, plot support • Lead served as ICT5-t on Lindbergh Fire at GRCA • Initial attack support on multiple Type 5 fires at GRCA • GISS support by Lead on multiple fires at GRCA • Sent all 3 crewmembers to 2-week Helicopter Training Academy at GRCA S Rim • Cross-trained crewmembers with GRCA engines, helitack, mechanical fuel reduction projects, fuel sampling • Provided IA coverage on N Rim while Engine 6-2 was out-of-park on 2 separate assignments
Training	7%	• All attended annual fire refresher • Sent 2 to S131 in Cortez, CO • Sent 1 to S211 in Cortez, CO • Sent 3 to S212 at GRCA, S Rim • Sent 3 to S271 at GRCA, S Rim • Sent 1 to S290 in Cortez, CO • Sent 1 to S290 in Cedar City, UT
Other	15%	• 3 assisted evacuation of N Rim during Warm Fire on Kaibab NF • 3 assisted litter carryout of injured visitor on North Kaibab Trail • 10% of crew time spent on paid or unpaid leave

Table 4. Fire Ecologist Focus Areas/Accomplishments 2006

Focus Area	Percent Time	Notes
Planning	40%	• Coordinate FMP EIS development • Arrange USFWS & Tribal Consultations • Craft Interagency Agreement for FMP EIS • Craft funding proposal for FMP EIS • Coordinate and lead IDT meetings • Coordinate interagency field trips and meetings for FMP EIS • Conduct annual minimum requirement analysis (MRA) for fire effects monitoring program • Review wildland fire ecology literature
Task Groups	5%	• GRCA Vegetation Classification and Mapping Project • GRCA Fire IDT – Project Reviews (WFU and Rx) • Respond to external Fire Information requests • Review park research proposals related to vegetation & fuels
Data Analysis	6%	• Provide fuels and weather inputs for FMP fire behavior modeling • Review of FLAMMAP, FARSITE & BurnPro simulations for 5 FMP EIS Alternatives • Review of 2006 Annual Report monitoring variables and results
Supervision	20%	• Recruit and hire Assistant Lead Monitor and seasonal crew members • Provide program guidance and evaluate Lead Monitor performance • Manage project accounts and acquire supplies and material
Fire Assignments	5%	• PIOF on 4 RX fires at GRCA • PIOF for all WFU and suppression fires at GRCA • PIO2(t) on 4 wildfires in AZ, CA, ID
Training	4%	• Annual Firefighter Refresher • S-260 • S-270 • Supervisory Workshop (16-hrs)
Other	20%	• Paid leave • Daily PT for fire fitness

III. FIRE EFFECTS PLOT WORKLOAD

The 2006 season proved to be the third-busiest year for the Grand Canyon Fire Effects program as judged by overall plot workload. A total of 60 visits were made to permanent FMH-style plots, including a record 18 Year-5 reads. In order to supply managers with data from upcoming prescribed burns and provide the crew with plot installation experience, we installed 5 FMH forest plots in South Rim Ponderosa (PIPO) and North Rim Ponderosa with White Fir Encroachment (PIAB) vegetation types. Due to the cancellation of multiple prescribed burns on the North Rim, we only had 5 immediate post-burn visits in conjunction with completed prescribed fires. No plots

burned this year in any WFU or suppression incidents. On the CBI front, 137 non-permanent severity plots were installed one year following six prescribed and fire use fires from 2005. As usual, the vast majority of the fires and plot work occurred on the North Rim.

Table 5. Fire Effects Plot Workload 2006

Rim	Monitoring Unit	Plot Type	Install/ Pre-burn	Immed. Post-burn	Year 1	Year 2	Year 5	Year 10	Annual Total	Total FMH Plots
South	Ponderosa Pine	FMH	3	5	8	3		1	20	37
South	Pinyon-Juniper Woodland	FMH								17
South	Long Jim I Rx	CBI	16						16	
South	Topeka Rx	CBI	18						18	
North	Ponderosa Pine	FMH	3		6	6	11		26	30
North	Ponderosa Pine w/ White Fir Encroachment	FMH	3			2	7		12	26
North	Rocky Mountain Subalpine Conifer	FMH	1			1			2	17
North	Grassland Interior	FMH								10
North	Grassland Edge	FMH								6
North	Dragon WFU	CBI	51						51	
North	Cape Royal Rx	CBI	27						27	
North	Atoko Rx	CBI	13						13	
North	Cape Final Rx	CBI	12						12	
Total			147	5	14	12	18	1	197	143

"Total FMH Plots" includes all permanent FMH plots installed to date within a monitoring unit/type

IV. MONITORING OBJECTIVES & RESULTS

FMH

Grand Canyon National Park's Fire Effects monitoring program has installed 143 permanent Fire Monitoring Handbook (FMH)-style plots to date and has burned 100 of these same plots. This large body of data allows us the luxury of being able to report results to our desired level of statistical accuracy for almost all of our major management objectives. Of the 15 objectives listed below, we can confidently say we are achieving nine of them and the trend is so far very positive on another six.

Table 6. Management Objectives and Monitoring Results 2006

Monitoring Unit	Management Objectives	Monitoring Results (n = # of plots)	Objectives Achieved?	Minimum Plot #s Achieved?
Ponderosa Pine (PIPO) South Rim	Reduce total fuel load to 0.2-9.3 tons/acre immediate post-burn	7.8 tons/acre (-51%) (n=31)	YES	YES n=8
	Limit crown scorch on trees (PIPO) with DBH ≥16" to <30% immediate post-burn	19.4% crown scorch (n=30)	YES – Results are for all trees >6" DBH, so % is likely lower for trees ≥16"	YES n=15
	Reduce poles (PIPO) with DBH of 1-6" to <200 trees/acre 2 years post-burn	118.8 trees/acre (-19.5%) (n=17)	YES	NO n=104
	Achieve overstory (PIPO) density with DBH ≥16" of 19-25 trees/acre 5 years post-burn	19.7 trees/acre (-0%) (n=21)	YES	YES n=13
Pinyon-Juniper Woodland (PIED) South Rim	Reduce total fuel load to <20 tons/acre immediate post-burn	9.0 tons/acre (-24.7%) (n=13)	YES	YES n=5
	Limit overstory tree (all species) mortality to <20% 5 years post-burn	12.4% mortality (n=12)	YES	YES n=4
Ponderosa Pine (PIP) North Rim	Reduce total fuel load to 0.2-9.3 tons/acre immediate post-burn	13.8 tons/acre (-59.3%) (n=26)	NO – Getting close, but second-entry treatment likely needed	YES n=9
	Limit crown scorch on trees (PIPO) with DBH ≥16" to <30% immediate post-burn	19.9% crown scorch (n=26)	YES – Results are for all trees >6" DBH, so % is likely lower for trees ≥16"	YES n=5
	Reduce poles (PIPO) with DBH of 1-6" to <200 trees/acre 2 years post-burn	69.4 trees/acre (-45.6%) (n=26)	YES	NO n=80
	Achieve overstory (PIPO) density with DBH ≥16" of 40-56 trees/acre 5 years post-burn	43.5 trees/acre (-4.9%) (n=20)	YES	YES n=4

Monitoring Unit	Management Objectives	Monitoring Results (n = # of plots)	Objectives Achieved?	Minimum Plot #s Achieved?
Ponderosa Pine w/ White Fir Encroachment (PIAB) North Rim	Reduce total fuel load to 0.2-20 tons/acre immediate post-burn	20.7 tons/acre (-49.8%) (n=14)	NO – But very close indeed. Larger sample size may show objectives achieved	YES n=7
	Limit crown scorch on trees (PIPO) with DBH ≥16" to <30% immediate post-burn	10.9% crown scorch (n=14)	YES – Results are for all trees >6" DBH, so % is likely lower for trees ≥16"	YES n=9
	Reduce poles (ABCO) with DBH of 1-6" to <100 trees/acre 2 years post-burn	53.7 trees/acre (-78.8%) (n=19)	YES	NO n=24
	Achieve overstory (PIPO) density with DBH ≥16" of 19-25 trees/acre 5 years post-burn	20.2 trees/acre (-19.8%) (n=13)	YES	YES n=9
Rocky Mountain Subalpine Conifer (PIEN) North Rim	Reduce total fuel load immediate post-burn	Reduction from 62.8 to 30.2 tons/acre (-51.9%) (n=2)	YES – No quantitative goal established, but trend is of solid reduction	NO n=7

Assessment of objective success and fulfillment of minimum plot requirements are based on 80% confidence intervals, with R-value of 20.

CBI

Composite Burn Index (CBI) burn severity assessments have been occurring annually at Grand Canyon since 2001. Between 2001-2006, 665 CBI-style plots have been installed in the park, providing Normalized Burn Ratio (NBR) satellite-correlated severity data on 21 fires over 68,000 total acres. This process is designed for field data and satellite imagery gathered one year following a fire; hence, 2006 work was performed on fires which burned in 2005. For the second consecutive year, the fire effects crew installed CBI plots in both prescribed burns and wildland fire use incidents. Our gracious subjects this year were the 2005 Dragon Wildland Fire Use & Atoko, Cape Final, Cape Royal, Long Jim I, and Topeka Prescribed fires at GRCA. Composite severity graphs reflect much lighter overall burning on the South Rim during the 2005 season. This is not unexpected as all South Rim burns were prescribed fires conducted late in the fall. The North Rim graph reflects three prescribed fires and two fire use events, all of which occurred in-season and mostly in areas burned since 1998. The Dragon Fire Use was

the focus of our efforts, and a map reflecting the fruits of our labor is shown below. A total of 137 CBI plots were installed in 2006 to help provide these numbers.

Figures 1 and 2. Burn severity by percent and acres for 2005 fires at Grand Canyon

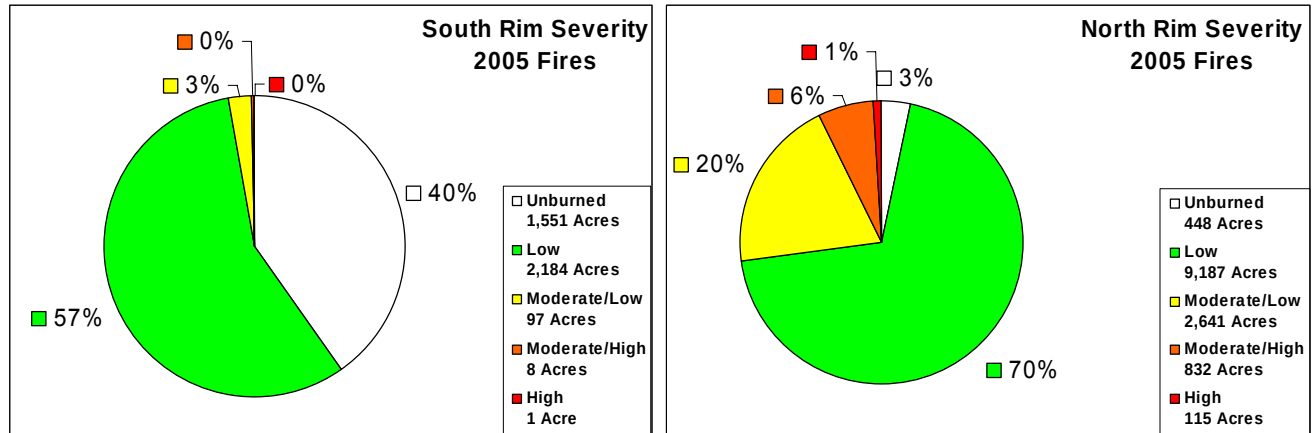
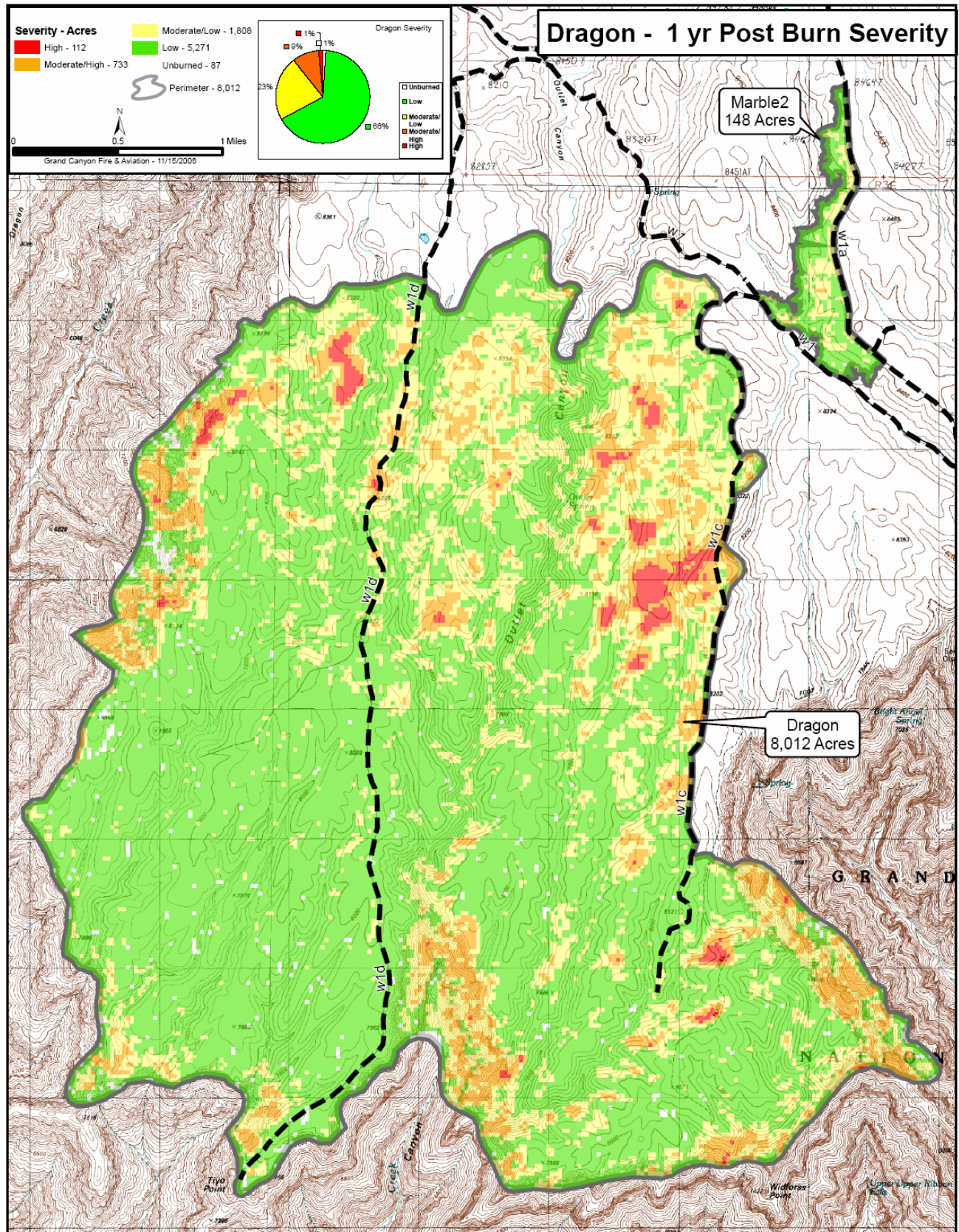


Figure 3. An example of the "Low" severity prevalent in the 2005 fires



Figure 4. Burn severity final map for 2005 Dragon Fire Use at Grand Canyon



V. ADDITIONAL ANALYSES:

RX VS. WILDLAND FIRE USE ON THE NORTH RIM

Here at Grand Canyon National Park, we are in the fortunate position of burning equally large acreages with both wildland fire use and prescribed fire treatments. Since 1980, over 50,000 acres have been burned by each treatment type, mostly within designated burn unit boundaries. As permanent FMH-style plots have been randomized and installed across the landscape of the North Rim, they, too, have burned in both fire use and prescribed events. This combination of management practices and happenstance has produced on the North Rim, 19 plots burned in first-entry prescribed (Rx) fires and 22 burned in first-entry fire use (WFU) in two of our main monitoring types. We now have five years of post-burn data for many of these 41 plots, and are in a position to present the results comparing prescribed and fire use treatments at Grand Canyon.

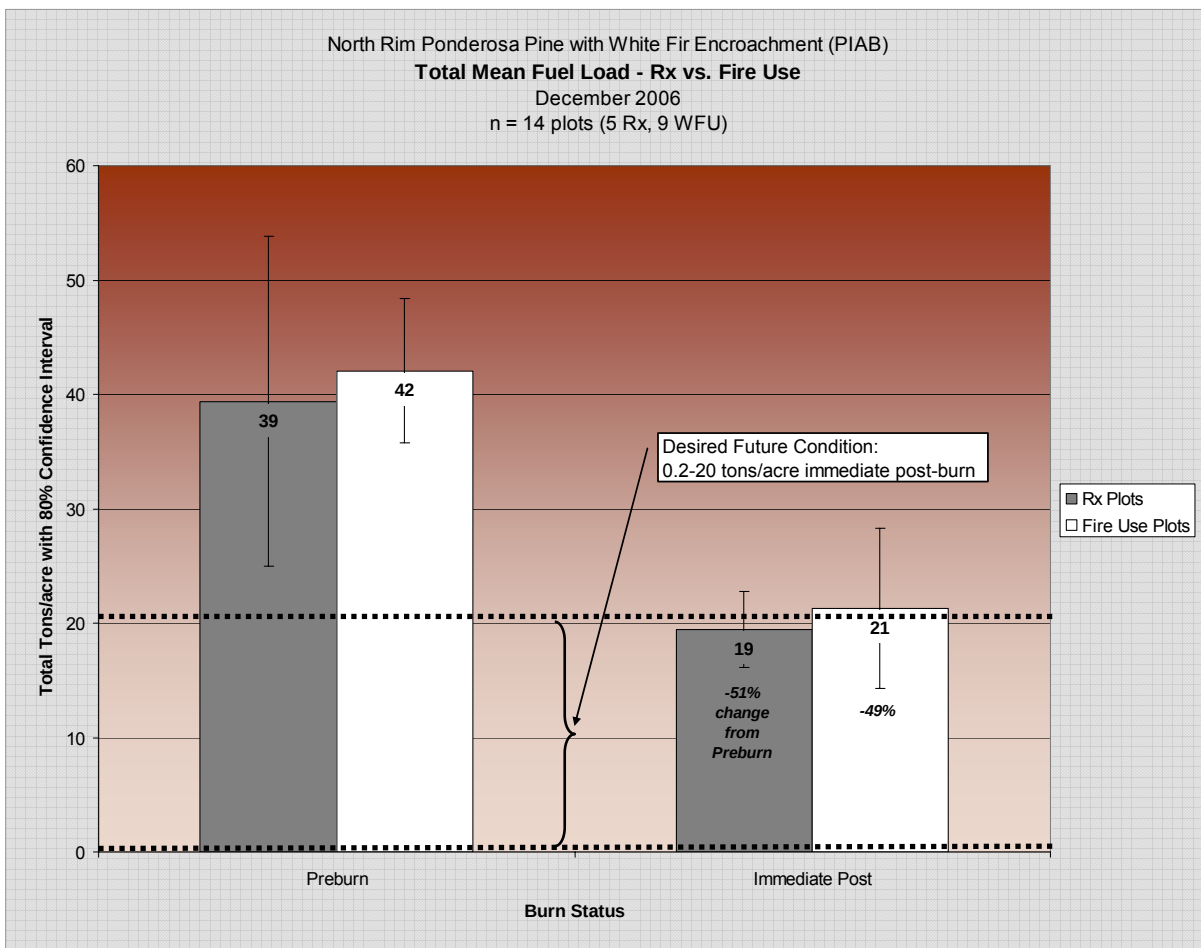
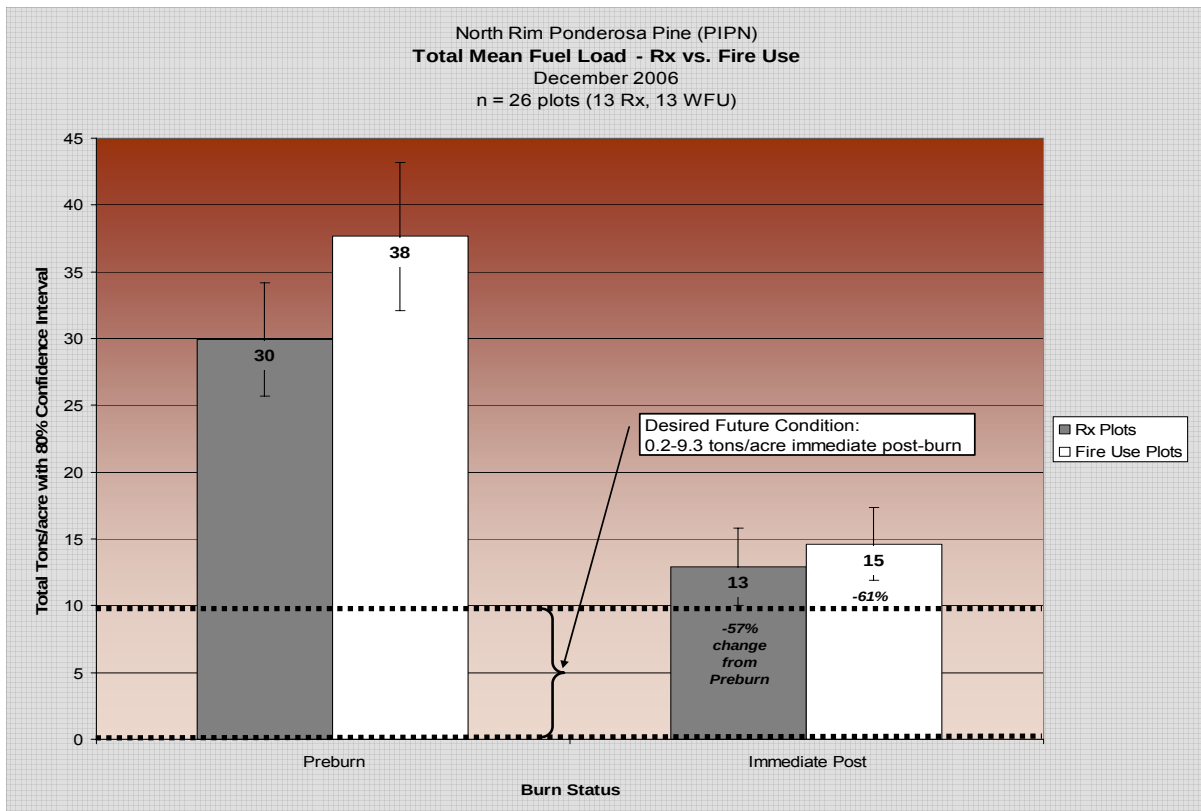
Preceding results in Table 5 reflected prescribed and fire use treatments lumped together for the North Rim Ponderosa Pine and Ponderosa Pine with White Fir Encroachment monitoring types. Here we will break out the results by treatment type for three of our management objectives.

Total Fuel Load

In the pure ponderosa monitoring type, total mean fuel load dropped an average of 57% in 13 Rx plots and 61% in 13 WFU plots immediately post-burn, following a first-entry treatment. While absolute values differ between treatment types, the relative change is nearly identical. Despite the impressive fuel load reduction, we haven't quite reached our desired future condition of less than 9.3 tons/acre. This suggests a second-entry treatment or revisiting our first-entry objectives will be necessary.

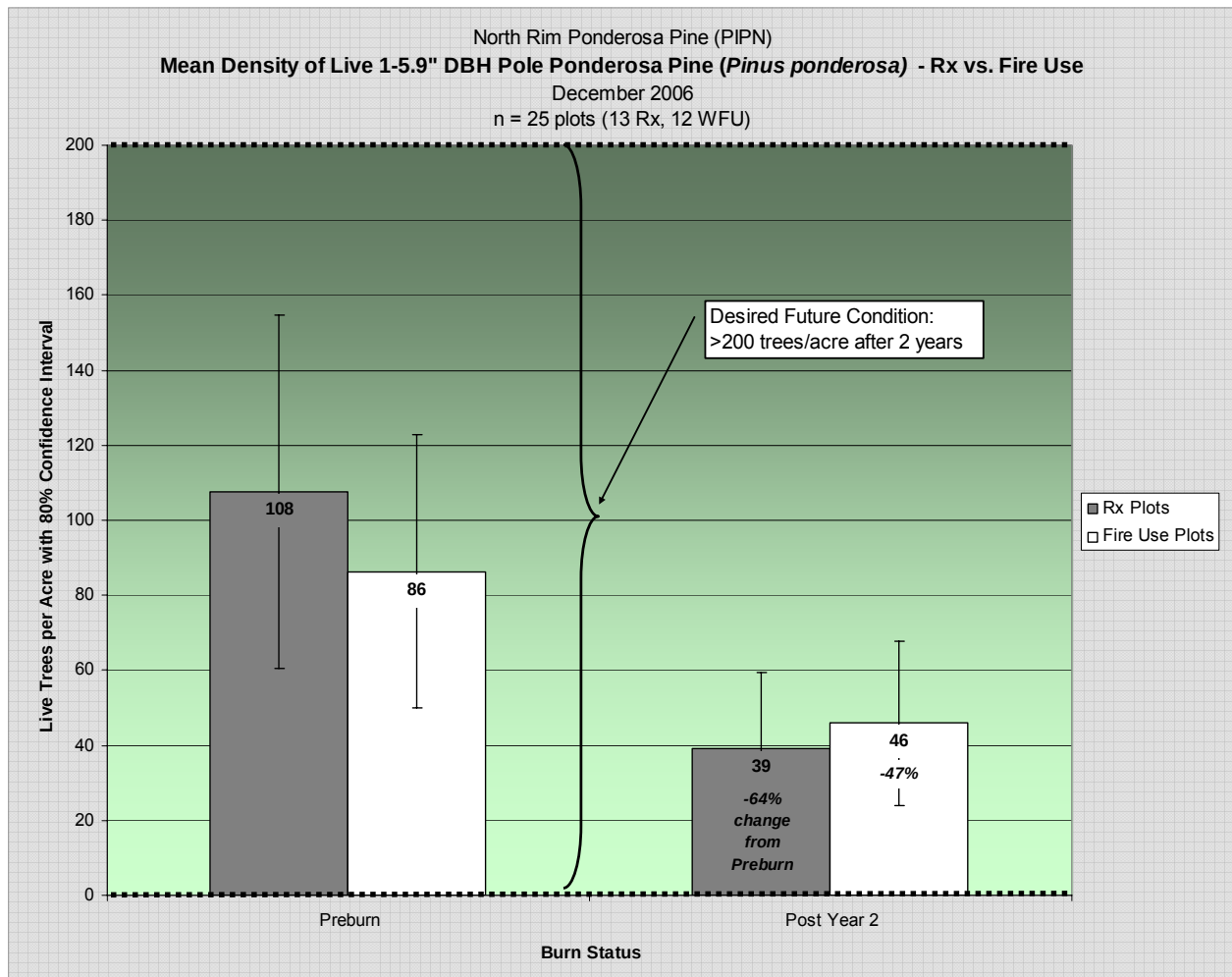
The results for the mixed ponderosa pine and white fir monitoring type are very similar. Reductions of total fuel load are about 10% less than in the pure ponderosa, but almost identical for prescribed and fire use treatments. Here our first-entry objectives are less aggressive and we are right at the upper limit of our desired future condition. Error bars are a bit wider for the pre-burn prescribed values due to a smaller sample size.

These numbers reflect a great similarity in fuel reduction effectiveness between prescribed and fire use burns at Grand Canyon. Within each monitoring type, the differences in percent reduction are not statistically significant, owing more to variations in individual plots than treatment methods, in all likelihood.

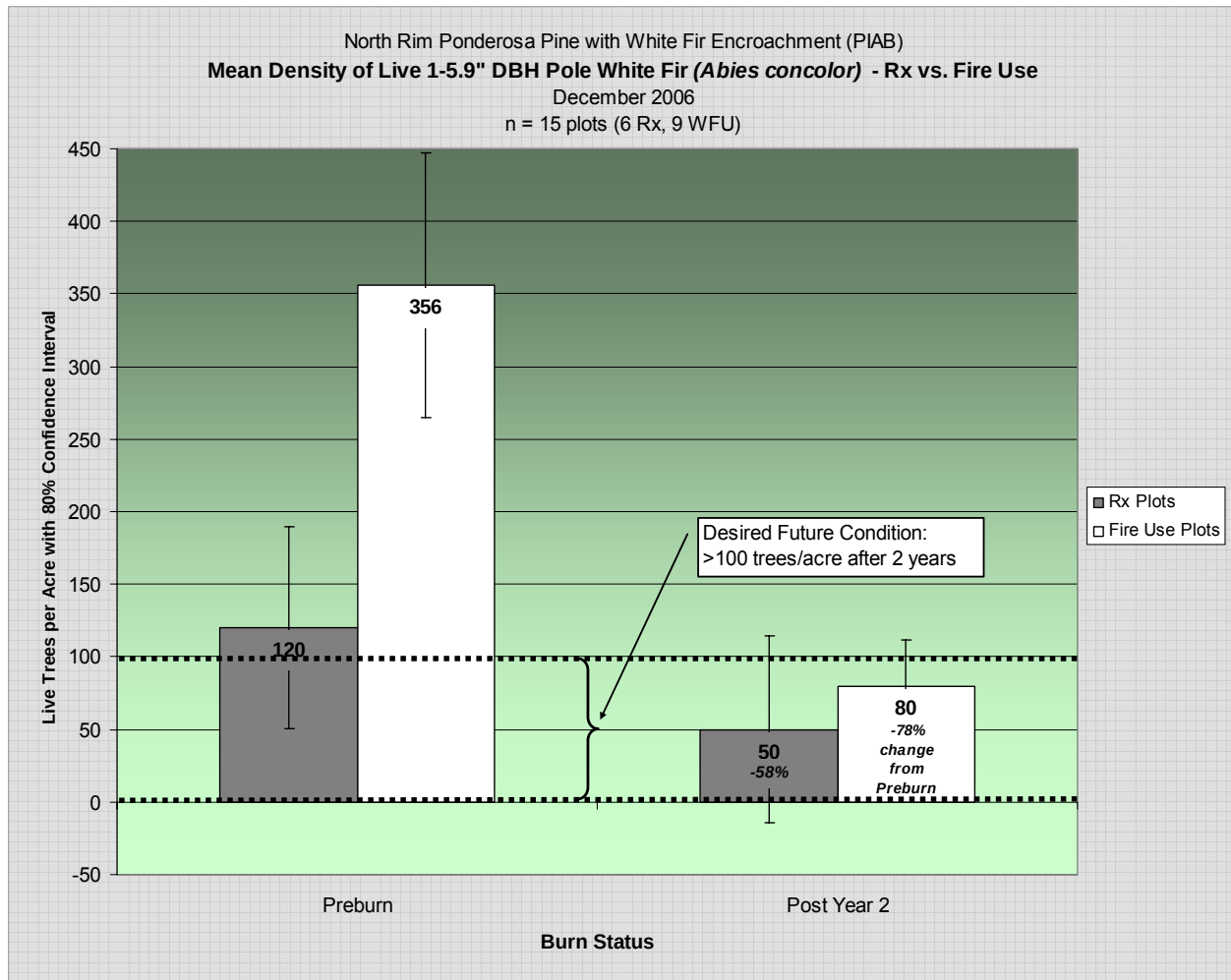


Pole Density

Pole densities are evaluated according to species at Grand Canyon. In pure ponderosa, our goal is to achieve ponderosa pole densities less than 200 trees/acre. A comparable selection of plots demonstrates pole reductions of 47% in fire use and 64% in prescribed fires; however, pre-burn conditions already were well within the desired future condition range. These results and the original objective warrant further discussion during the next monitoring plan revision.



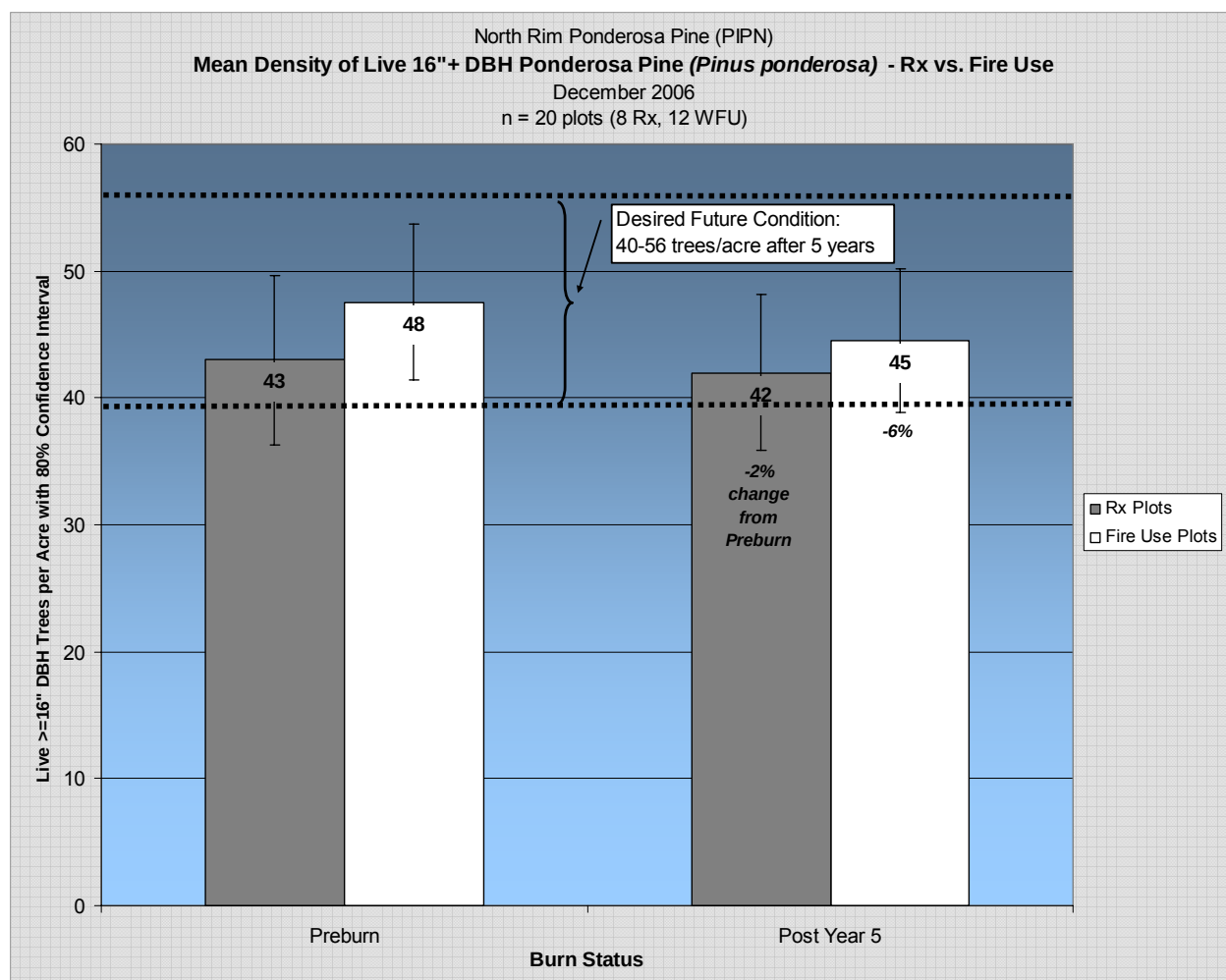
Percent reduction numbers are flip-flopped for areas of ponderosa with white fir encroachment. In this denser monitoring type white fir is the species of concern, and fire use showed 78% reduction while prescribed burning only dropped pole numbers 58%. There is a glaring disparity between pre-burn densities in the two treatment types, with the nine plots burned in fire use demonstrating triple the amount of trees as the six burned in prescribed fires. Nonetheless, results recorded two years post-burn show a drop in densities for both types of treatments within the desired range of less than 100 trees/acre.



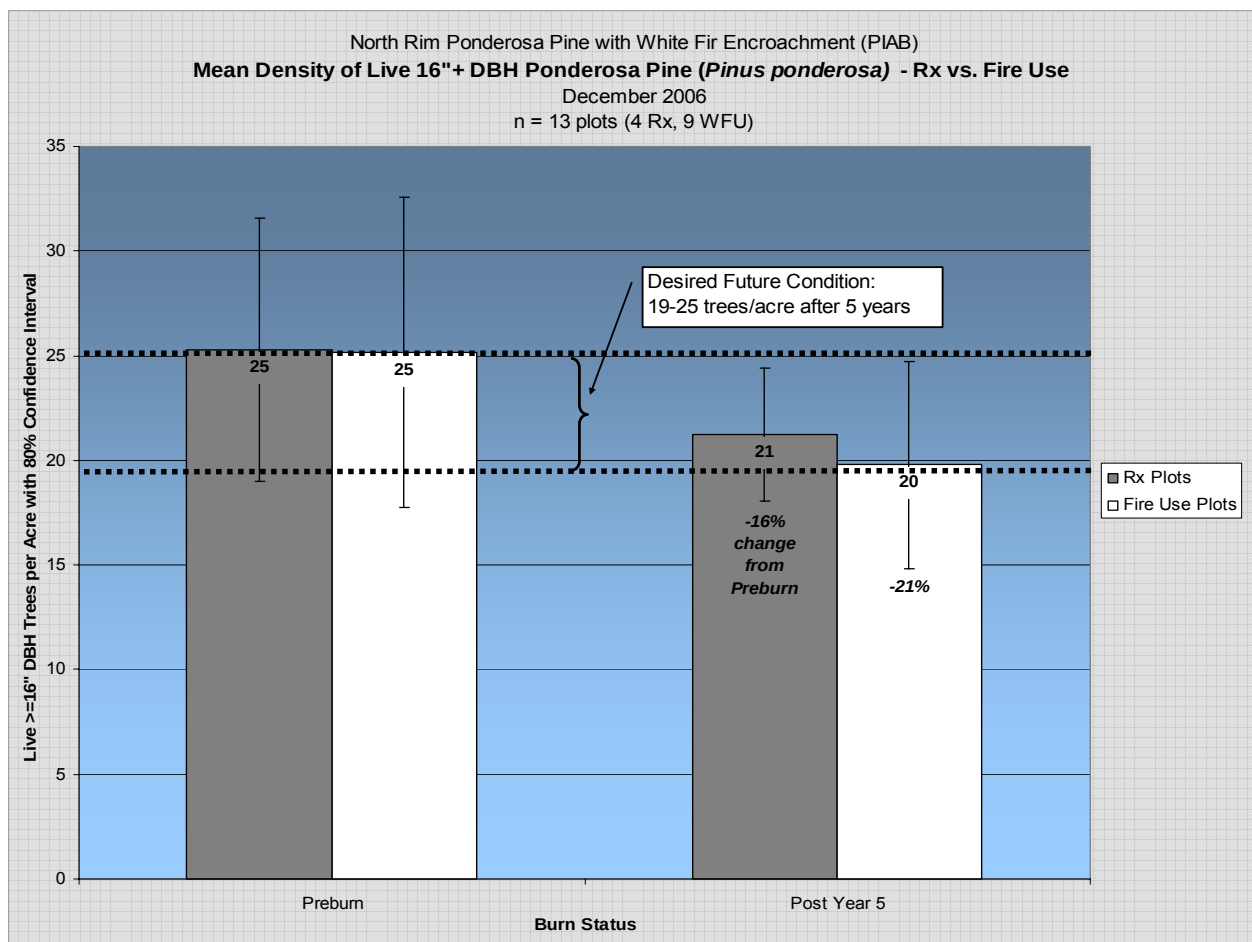
Similar to the fuel loading results, it can be argued that prescribed and fire use treatments both seem to be doing an effective job. Minor variations aside, pole densities on average have dropped by at least half for all treatment types in both pure ponderosa and "mixed conifer" vegetation types.

Overstory Density

Keeping with the trend of comparing results in relation to our standard monitoring objectives, here we look at changes to overstory ponderosa pine trees with DBH $\geq 16''$. In pure ponderosa pine, we would like to achieve a desired future condition of 40-56 trees/acre in this size class, with the subsidiary goal of limiting mortality to 20%. It appears safe to say we have accomplished the dual objectives with both fire use and prescribed treatments. We were already within the desired range pre-burn, and kept mortality to less than six percent with both types of fire. The sample size here is slightly smaller ($n = 20$) than for our other analyses as we do not yet have five year post-burn data for five of the prescribed plots.



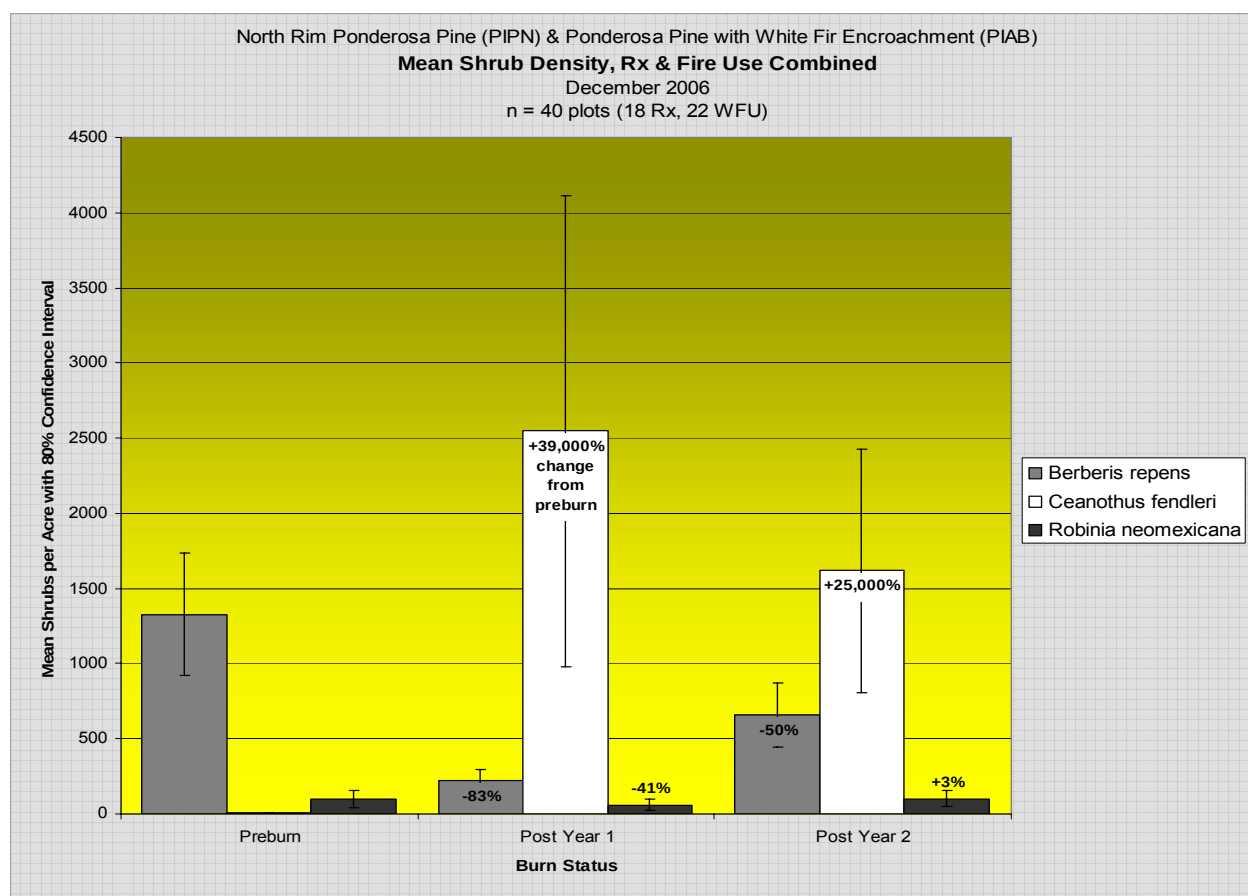
Once again, we have apparent success in ponderosa with white fir encroachment. The desired future condition of 19-25 trees/acre in ponderosa pine $\geq 16''$ DBH is half the density of the pure ponderosa monitoring type, owing in part to multiple overstory species competing for the same resources. Pre-burn we were at the upper end of the range and five years post-burn we are at the low end of the desired range. As might be expected, the percent mortality is higher in "mixed conifer" due to factors such as higher understory tree densities and the prevalence of ladder fuels. For fire use treatments, we have slightly exceeded the goal of limiting mortality to 20%, yet we are still within our density range of success for the objective. It appears as though these two objectives could be conflicting under some circumstances, and it begs the question as to which is paramount.



Taken as a whole, these data seem to demonstrate not only that first-entry prescribed fire and fire use are equally effective tools, but that they are being applied under consistent conditions at Grand Canyon. That there is no great disparity in results between treatment types strongly suggests that both prescribed burning and fire use continue to be employed as management strategies.

PREFERRED BROWSE SHRUB RESPONSE ON THE NORTH RIM

Grand Canyon's Wildlife Biologist recently expressed interest in the response of preferred browse shrub species to fire. While initially it seemed intriguing to break out results by treatment type and monitoring type as done for our main objectives, doing so yielded no significant differences. Therefore, we chose to present the results for the entire body of data on the North Rim in the pure ponderosa and ponderosa with white fir encroachment monitoring types. Although other shrub species are present, numbers were too insignificant to report. Creeping barberry (*Berberis* or *Mahonia repens*) was not identified as a preferred browse species, but it is one of the most common species encountered, so we included it for comparison.



Both *Ceanothus* and *Robinia* show net increases by two years post-burn, while *Berberis* is not yet recovered to pre-burn conditions. *Robinia* takes longer to respond while *Ceanothus* seems to peak one year post-burn. The exceptionally strong response from *Ceanothus* is noteworthy. For at least these species in question on the North Rim, fire treatments seem to have a positive effect on preferred browse shrubs.

And what will 2007 bring???

(NOTE: no Fire Effects personnel were harmed or permanently incarcerated in the making of this report)



CONTACTS

Mary Rasmussen
Fire Ecologist
mary_rasmussen@nps.gov
928-638-7947

Li Brannfors
Lead Fire Effects Monitor
li_brannfors@nps.gov
928-638-7942

Missy Spandl
Assistant Lead Monitor
melissa_spandl@nps.gov
928-638-7942