National Park Service
Northern Great Plains Fire Ecology
Annual Report
Calendar Year 2011

A. Summary

2011 was a very productive year for the Northern Great Plains (NGP) fire ecology program. A total of 238 plots of various types were measured, an all time high for the program. Seven prescribed fires occurred in the NGP parks, resulting in 21 plots being burned, 19 of which were measured immediately post-burn.

This was the second year of a three year research project at Wind Cave N.P., Jewel Cave N.M., and Devils Tower N.M. in which Dan Swanson partnered with Amy Symstad of the USGS assessing the relationship between prescribed fire burn severity and target invasive plant species abundance taking into account a variety of pre- and post-fire environmental characteristics at each park. This past season two seasonals collected year one post-burn data on 90 plots at Wind Cave N.P. and Jewel Cave N.M. Data analysis comparing preburn to year one post-burn effects will be done during the winter/spring of 2012.

This year we continued collaboration with the NPS Northern Great Plains Inventory and Monitoring Network (I&M). Since the ten parks that the NGP fire ecology program monitor fire effects in are encompassed within the fourteen parks that the Northern Great Plains I&M program have, an excellent opportunity for collaboration existed. The NGP fire effects crew and I&M program installed 60 forest and fuels-style plots at Jewel Cave NM which are spatially balanced throughout the park and revisited once every five years by the I&M program. If any of these plots are burned in a prescribed burn project, the NGP fire effects program will revisit them at the standard FMH monitoring sequence. In addition, since both programs are using the same sampling design and monitoring protocols, we were able to coordinate plot sampling visits this year throughout our park network. Therefore, both programs are now benefiting from this collaboration by sharing data from their monitoring efforts.

This past August the monitoring crew and fire ecologist completed 48 composite burn index (CBI) plots within the American Elk RX burn unit at Wind Cave N.P. to ground truth the satellite-based burn severity assessment. The extended assessment revealed a mixed severity fire consisting of 48% low, 41% low-moderate, 5% moderate, and 4% high severity. This 3450 acre unit was burned in October 2010 and was the largest burn in Wind Cave N.P. history. Regression analysis will be completed this winter using the ground-truthed CBI plot data and the satellite-based dNBR values.

Table 1. Fire Effects Plot Workload (2011) and Total Plots Installed

Park	Monitoring Unit	Type of Plot (FMH, photo point, other)	Pre-burn 2011	Imm. Post 2011	Postburn (1-20 yrs) 2011	Annual Total (2011)	Total Plots
Agate Fossil Beds	Mixed grass prairie	Grassland Fuels Veg. Plot (GFV)	1	1	3	5	4
	Mixed grass prairie	I&M Veg Plot			3	3	6
Badlands	Mixed grass prairie	FMH Grass Plot			5	5	26
	Mixed grass prairie	GFV Plot					3
	Mixed grass prairie	I&M Veg Plot		7	7	14	21
	Shrubland	FMH Shrub Plot			2	2	4
Devils Tower	Ponderosa forest	FMH Forest Plot			2	2	14
	Mixed grass prairie	FMH Grass Plot			1	1	3
	Ponderosa forest	Forest, Fuels, and Veg. Plot (FFV)			3	3	3
	Ponderosa forest	Forest & Fuels Plot (F&F)					3
	Mixed grass prairie	I&M Veg Plot	3			3	3
Fort Union	Cottonwood forest	FMH Forest Plot					1
	Mixed grass prairie	FMH Grass Plot					2
Jewel Cave	Ponderosa forest	FFV Plot			1	1	6
	Ponderosa forest	F&F Plot					3
	Ponderosa forest	FMH Forest			3	3	3
	Ponderosa forest	I&M Forest & Fuels Plot	26			26	62
Knife River	Mixed grass prairie	GFV Plot		6	6	12	6
	Mixed grass prairie	FMH Grass Plot		2	2	4	6
	Green ash forest	FMH Forest Plot			1	1	3
	Mixed grass prairie	I&M Veg Plot	3		3	6	9
Mount Rushmore	Ponderosa forest	I&M Forest & Fuels Plot	13			13	60
Scotts Bluff	Mixed grass prairie	FMH Grass Plot		3	6	9	12
	Mixed grass prairie	I&M Veg Plot	14			14	16
	Juniper Woodland	FMH Forest Plot					2
	Shrubland	FMH Shrub Plot			1	1	3
Theodore Roosevelt	Mixed grass prairie	FMH Grass Plot			2	2	9
	Mixed grass prairie	GFV Plot					2
	Mixed grass prairie	I&M Veg Plot	6			6	7
	Juniper Woodland	I&M Veg Plot					5
	Cottonwood Forest	FMH Forest Plot			2	2	2
	Shrubland	FMH Brush Plot			2	2	5
Wind Cave	Mixed grass prairie	FMH Grass Plot			4	4	14
	Ponderosa forest	FMH Forest Plot			1	1	5
	Ponderosa forest	FFV Plot			3	3	3
	Ponderosa forest	F&F Plot			11	11	11
	Ponderosa forest	I&M Forest, Veg, & Fuels	7			7	14
	Ponderosa forest	I&M Forest & Fuels Plot			7	7	8
	Mixed grass prairie	I&M Veg plot	5			5	5
	Ponderosa forest	CBI plot			48	48	48
Photo Points, various parks	Mixed grass prairie	Photo point			3	3	15
	Ponderosa forest	Photo point			4	4	6
	Juniper woodland	Photo point	5			5	7
Total			**83**	**19**	**136**	**238**	**422**

Table 2. Fire Ecology Staffing 2011

Ecologist and Monitors	Starting Date	Ending Date	# of Pay Periods	READ qualified	Training and Development
Dan Swanson	1/1/2011	12/31/2011	26	No	Black Hills Area Bot/Eco workshop, Operational Leadership training, WICA climate change workshop, Adaptation Planning for Grasslands & Forests in the Black Hills Conference, MWR / IMR Fire Ecology Workshop, 7 fire operational periods
Valena Hofman	4/11/2011	10/22/2011	14	No	S-211, ATVO recert, 10-day assignment with BLHI WFM, worked on FALA, FFT1, 22 fire operational periods
Marcus Lund	5/16/2011	11/5/2011	12.5	No	S-234, ATVO recert, WFR recert, 10-day assignments with BLHI WFM, worked on FALB, 19 fire operational periods
Danielle Klaas	5/16/2011	8/18/2011	7	No	ATVO, botany training, 7 fire operational periods
Kevin Terlep	5/16/2011	8/18/2011	7	No	S-290 online course, ATVO, botany training,
Michael Bugosh	5/16/2011	8/18/2011	7	No	ATVO, opened and worked on FALB, opened FEMO, botany training

Table 3. 2011 Management Objectives and Monitoring Results

All results shown are 80% confidence intervals of the mean. Fuel reduction objectives/results are mean percent reduction from pre-burn to immediate post-burn. Stand density objectives/results are for five-year post-burn mean stand density. An underlined number of plots indicates that the minimum sample size has been attained for that variable.

Park	Monitoring Unit	Management Objective	Monitoring Results (80% C.I.)	Objective Achieved	Year Last Analysis Completed
Wind Cave N.P.	Native Mixed-grass Prairie	Increase the relative cover of native grasses by at least 10% within two growing seasons after the burn	5% Decrease	No; N=7	2008
		Increase the relative cover of native forbs by at least 30% within two growing seasons after the burn	No change	No; N=7	
		Decrease the relative cover of non-native grasses by at least 20% within two growing seasons after the burn.	23% Decrease	Yes; N=6	
	Non-native Grass Prairie	Increase the relative cover of native grasses by at least 20% within two growing seasons after the burn	59% Increase	Yes; N=5	2008
		Increase the relative cover of native forbs by at least 20% within two growing seasons after the burn	No change	No; N=5	
		Decrease the relative cover of non-native grasses by at least 30% within two growing seasons after the burn.	No change	No; N=5	
	Ponderosa Pine Forest	Increase the relative cover of native herbs by at least 25% within two growing seasons after the burn	17% Decrease	No; N=5	2008
		Decrease the relative cover of non-native herbs by at least 25% within two growing seasons after the burn	No change	No; N=5	
		Reduce the density of overstory ponderosa pine (≥ 14.9 cm dbh) by at least 30% two growing seasons after the burn.	6% Decrease	No; N=9	
		Reduce the density of pole-size ponderosa pine (2.5 – 14.8 cm dbh) by at least 50% two growing seasons after the burn.	No change	No; N=9	
		Reduce the density of seedling ponderosa pine by at least 70% one growing season after the burn	78% Decrease	Yes; N=9	
		Reduce total fuel loading by at least 30% following one prescribed burn	21% Decrease	No; N=9	
Devils Tower N.M.	Non-native Grass Prairie	Increase the relative cover of native grasses by at least 10% within two growing seasons after the burn	39% Increase	Yes; N=3	2008
		Increase the relative cover of native forbs by at least 20% within two growing seasons after the burn	74% Increase	Yes; N=3	
		Decrease the relative cover of non-native grasses by at least 20% within two growing seasons after the burn.	49% Decrease	Yes; N=3	
	Ponderosa Pine	Increase the relative cover of native grasses by at least 10% within two growing seasons after the burn	13% Increase	Yes; N=7	2008
		Increase the relative cover of native forbs by at least 10% within two growing seasons after the burn	36% Increase	Yes; N=6	
		Decrease the relative cover of non-native grasses by at least 30% within two growing seasons after the burn.	No change	No; N=7	
		Reduce total fuel loading by at least 30% following one prescribed burn	38% Decrease	Yes; N=7	
Badlands N.P.	Western wheatgrass Mixed-grass Prairie	Increase the relative cover of native grasses by at least 10% within two growing seasons after the burn	6% Decrease	No; N=20	2008
		Increase the relative cover of native forbs by at least 30% within two growing seasons after the burn	4% Increase	No; N=18	
		Decrease the relative cover of non-native grasses by at least 20% within two growing seasons after the burn.	No change	No; N=19	
	Non-native grass Prairie	Increase the relative cover of native grasses by at least 10% within two growing seasons after the burn	30% Increase	Yes; N=4	2008
		Increase the relative cover of native forbs by at least 10%	37% Increase	Yes; N=4	

		within two growing seasons after the burn Decrease the relative cover of non-native grasses by at least 30% within two growing seasons after the burn.	 No change	 No; N=4	
Theodore Roosevelt N.P.	Kentucky Bluegrass Non-native Prairie	Increase the relative cover of native grasses by at least 20% within two growing seasons after the burn Increase the relative cover of native forbs by at least 20% within two growing seasons after the burn Decrease the relative cover of non-native grasses by at least 30% within two growing seasons after the burn.	57% Increase No change 3% Decrease	Yes; N=3 No; N=3 No; N=3	2008
	Crested Wheatgrass Non-native Prairie	Increase the relative cover of native grasses by at least 20% within five growing seasons after the burn Decrease the relative cover of non-native grasses by at least 20% within five growing seasons after the burn.	No change No change	No; N=3 No; N=3	2008
	Native Mixed-grass Prairie	Increase the relative cover of native grasses by at least 20% within five growing seasons after the burn Decrease the relative cover of non-native herbs by at least 20% within two growing seasons after the burn.	8% Increase 8% Increase	No; N=3 No; N=3	2008
Agate Fossil Beds N.M	Native Mixed-grass Prairie	Increase the relative cover of native grasses by at least 20% within two growing seasons after the burn. Decrease the relative cover of non-native herbs by at least 20% within two growing seasons after the burn.	5% Increase (Yr 1) 31% Decrease (Yr1)	TBD TBD	2009

Wind Cave N.P.

The largest prescribed burn in the history of Wind Cave N.P. was completed October 20-21, 2010. The 3,450 acre American Elk unit was located primarily within forested communities of the park, but also included mixed-grass prairie, prairie dog towns, and ponderosa pine encroached meadows. The primary objective of the burn was to restore fire back into the project area since most of the unit hadn't experienced fire since the Park's creation in 1903. Additional resource objectives included reducing overstory, pole, and seedling densities. We also wanted to decrease the dead and down fuel loading within the forested communities and encroachment of ponderosa pine regeneration at the forest-prairie ecotone.

The first day of the burn consisted of two ignition teams blacklining approximately 12 miles of burn perimeter. Day two involved blacklining the final half-mile of burn perimeter and interior helicopter ignition. Approximately 39% of the unit was unburned to low, 29% low-low moderate, 26% moderate, and 6% high severity (Figure 1) based on the analysis of 48 CBI plots that were installed within the four burn severity classes.

This unit had seventy-five fire effects monitoring plots established in it which was the most for any unit and park within the Northern Great Plains park group. Fifty-seven of these plots were associated with a three-year invasive plant research project which was funded by research reserve funds. Since the research project's sampling design and plot layout were identical to most of the Northern Great Plains fire effects plots, I was able to analyze sixty of the fire effects plots together. All plots were read pre-burn between 2008 and 2010 and year 1 post-burn in 2011. Resource objectives included: 1) Achieve 20-50% mortality in overstory ponderosa pine (>6" dbh), 2.) Achieve 50-70% mortality in pole-size ponderosa pine (1-6" dbh), 3.) Achieve 70-95% mortality in ponderosa pine seedlings, 4.)Achieve > 40% reduction in 100 and 1000 hr fuel loading.

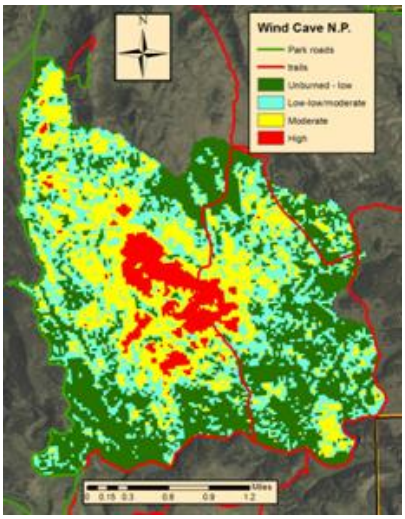

Figure 1. American Elk prescribed fire calibrated burn severity assessment map

Passive tree torching shortly after helicopter ignition commenced on October 21.

The paired fire effects data was analyzed for relative change using ratio of means (RoM) at an 80% confidence level. There was an average 29% mortality of overstory ponderosa pine trees with 80% confidence that it decreased between 23 and 37%. Pole-sized ponderosa pine decreased an average 64% with 80% confidence the mortality was between 55 and 72%. Ponderosa pine seedlings decreased an average 72% with 80% confidence the mortality was between 59 and 81%. 100 hr fuels decreased an average 61% with 80% confidence this fuel loading class decreased between 51 and 70%. 1000 hr fuels decreased by 36% with 80% confidence this fuel loading class decreased between 11 and 50%. Four of the five resource objectives were met and statistically significant with the fifth objective (1000 hr fuels) only slightly below target levels.

The several thousand acre unit allowed the prescribed fire to burn over multiple burn periods and weather conditions which replicates natural fire activity. The use of a helicopter provided for fire fighter safety by eliminating the need for interior hand ignition and enabled us to achieve a mosaic of burn severities across the landscape. Prescribed burns at Wind Cave N.P. are an integral tool for restoring these forests to their naturally diverse structure.

Jewel Cave N.M.

The 193 acre Lithograph prescribed burn was completed on September 21, 2010, which was the third entry of fire into this unit. Three ponderosa pine plots were installed within the Lithograph Canyon unit in 1998 prior to any fire treatments. Between the October 24, 1998, and September 22, 1999, prescribed fires, all three plots were burned. On August 25, 2000, the Jasper wildland fire burned across all three plots. A second prescribed burn occurred on September 21, 2010. Figure 2 shows that overstory tree (>6" dbh) density actually increased by 6%, while pole tree (1-6" dbh) density decreased by 63%. Overstory trees probably increased since some of the pole trees migrated into the larger size class. Figure 3 shows that seedlings decreased by 17%.

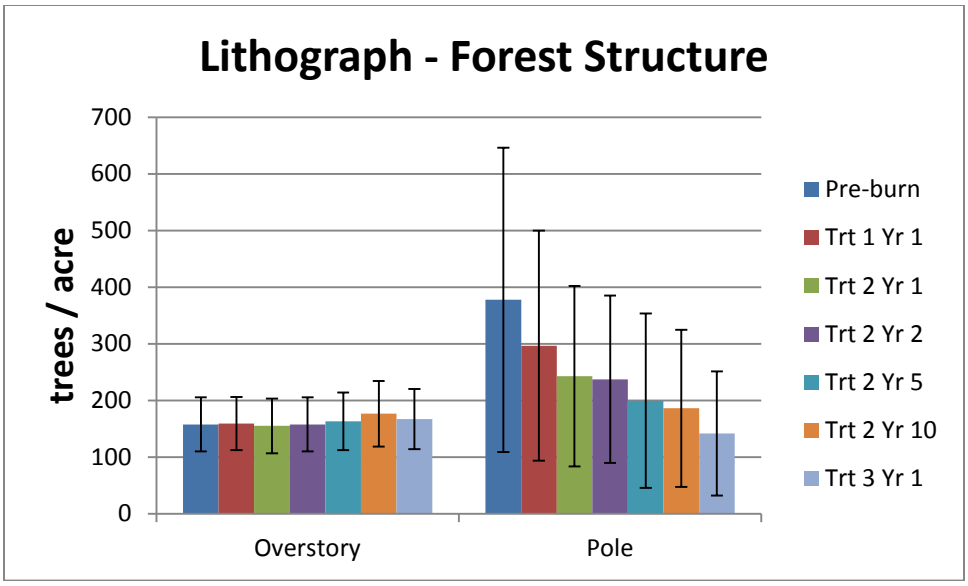

Figure 2 Ponderosa pine forest structure for three plots within the Lithograph unit following two prescribed burns and one wildfire.

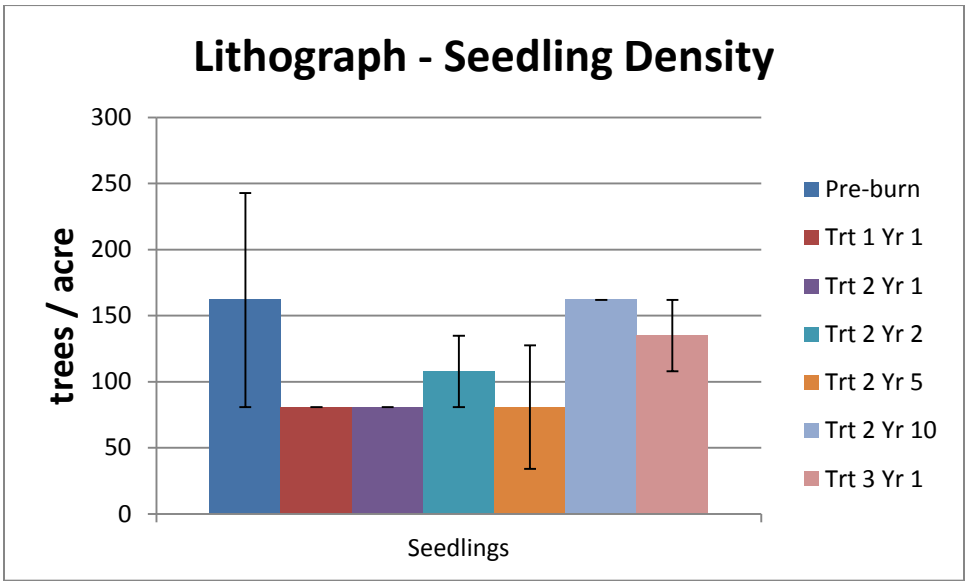

Figure 3 Ponderosa pine seedling density for three plots within the Lithograph unit following two prescribed burns and one wildfire.

Following two prescribed fires and one wildfire, native grass cover increased 17% from preburn to the first year after the third treatment (Figure 4). Non-native grass cover declined about 52% at Treatment 3 year 1comparted to pre-burn cover levels. Native forb cover increased by 40% at Treatment 3 year while non-native forb cover didn't change compared to preburn levels.

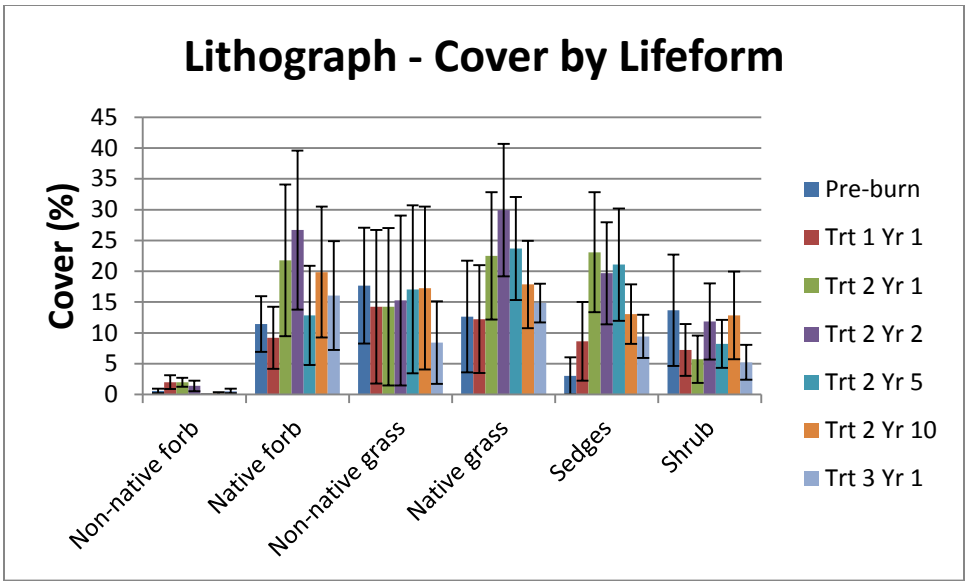

Figure 4 Percent vegetative cover by lifeform for three plots within the Lithograph unit following two prescribed burns and one wildfire.

Thirty two research plots were installed in the Lithograph burn unit within the ponderosa pine forest community in late June to late July 2010. The Lithograph prescribed burn was completed on September 21, 2010, and plots were reread in late June to late July 2011. Yellow sweetclover cover significantly increased (0.4% incremental change) between 2010 and 2011 (Figure 5). Houndstongue and common mullein are trending downward while Canada thistle is trending upward.

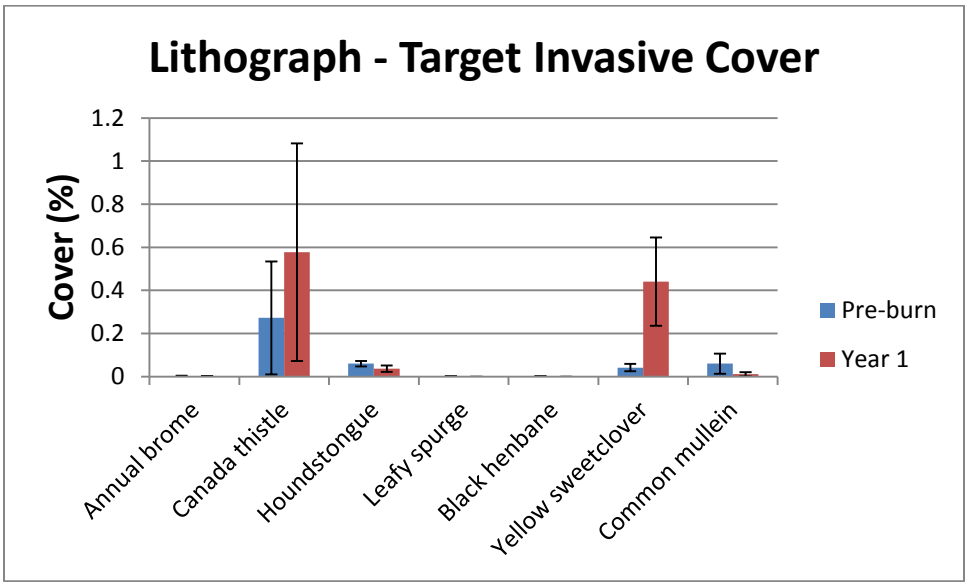

Figure 5 Percent vegetative cover by target species for thirty-two plots within the Lithograph unit following the September 21, 2010 prescribed fire.

Devils Tower N.M.

Seven ponderosa pine plots were installed within the Belle Fourche, Graham, Meadow, and Westside units between 1996 and 2001 and have had one prescribed fire. These plots were burned in prescribed fires that occurred in April 29, 1998 (Belle Fourche); November 15, 2001 (Graham); May 7, 1999 (Meadow) and October 21, 1999 (Westside). Resource objectives included limiting overstory mortality to less than 30%, reducing pole and seedling density, as well as decreasing non-native herbaceous cover by 30%. Nearly all of the overstory trees were ponderosa pine with just a few Rocky Mountain juniper and bur oak present. Overstory tree density (> 6" dbh) decreased for all three species: 12% for ponderosa pine, 29% for bur oak, and 100% for the Rocky Mountain juniper (Figure 6). Pole tree (1-6" dbh) density also decreased for ponderosa pine, bur oak, and Rocky Mountain juniper by 81%, 69%, and 100% respectively. There were relatively few ponderosa pine, bur oak, and Rocky Mountain juniper seedlings present prior to the burn. One year after the prescribed fire, there was a 100% decrease in ponderosa pine and Rocky Mountain juniper seedlings while bur oak increased by 145% from 127 to 312 trees per acre (tpa).

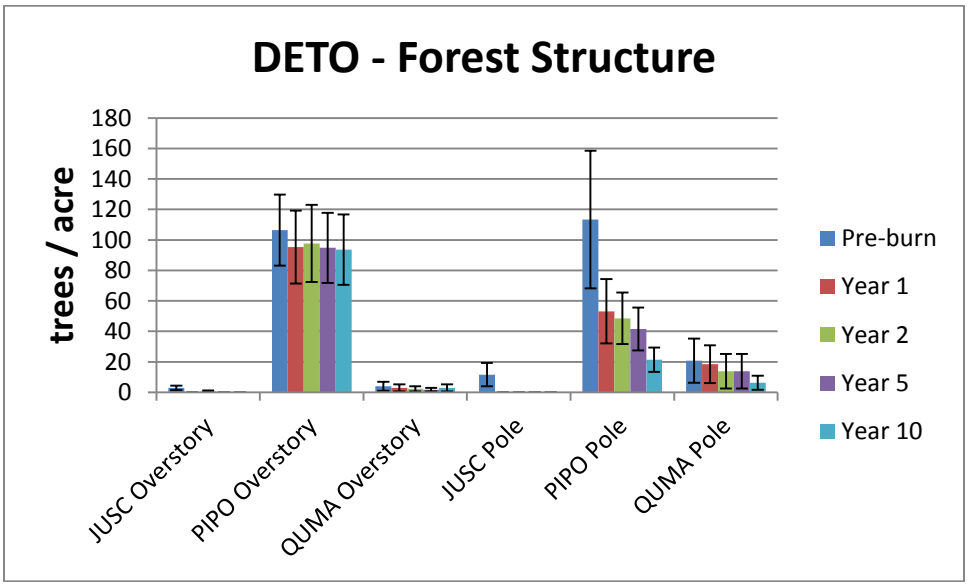

Figure 6 Forest structure for seven plots within the Belle Fourche, Graham, Meadow, and Westside burn units following one prescribed burn.

Following one prescribed burn native grass cover increased 44% by year ten (Figure 7). Non-native grass cover increased by 6% at year ten from pre-burn cover levels. Native and non-native forb cover increased by 7% and 28% respectively by year ten. I also looked at how the top five species in vegetative cover responded following one prescribed fire. I looked at relative change in cover from pre-burn to year ten. Western wheatgrass increased the most by 249% (Figure 8). Big bluestem and green needlegrass increased by 48% and 44% respectively. Kentucky bluegrass increased slightly at 15% while little bluestem decreased by 73%.

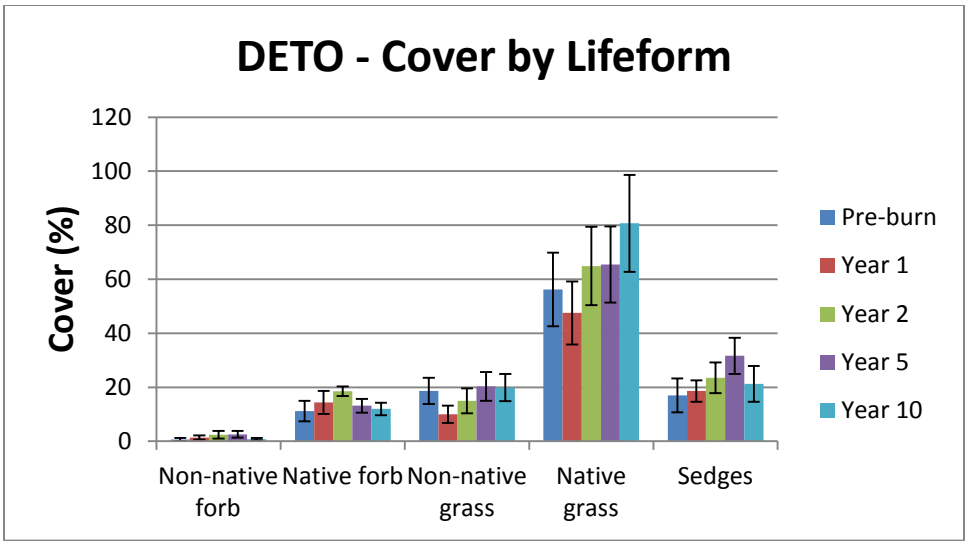

Figure 7 Percent vegetative cover by lifeform for seven plots within the Belle Fourche, Graham, Meadow, and Westside burn units following one prescribed burn.

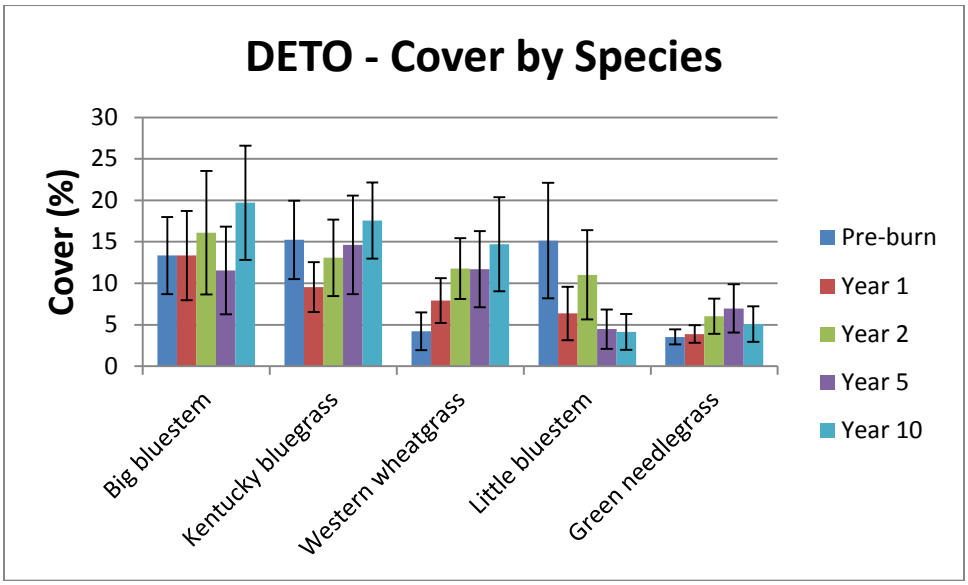

Figure 8 Percent vegetative cover by species for seven plots within the Belle Fourche, Graham, Meadow, and Westside burn units following one prescribed burn.

B. Fire ecologist accomplishments and areas of focus

Dan assisted with the development and edits of the fire regime component for Jewel Cave N.M., Devils Tower N.M, and Theodore Roosevelt N.P.'s natural resource condition assessment documents that have been completed. In addition he provided input and edits on the Badlands N.P. climate change vulnerability assessment document that's nearing completion. Dan is also

currently involved in a climate change research project at Wind Cave N.P. and has provided information on the area's fire regime and historical climate data.

In October Dan gave a fire ecology presentation to 7th grade students at The Nature Conservancy's Whitney Preserve near Hot Springs, SD.

I am working closely with the I&M vegetation ecologist and database manager as we dive into the next phase of sharing our monitoring data by exporting our databases. We are working out some of the kinks right now, e.g. ensuring our species lists and macroplot names match, and some minor data entry coding differences on the biological variables, but hope to have each others monitoring data within our databases by the end of winter. We envision ultimately having both program's data housed in park databases located on either the I&M or Wind Cave N.P. server. This would then eliminate the exporting of each others data since any data entry changes would be made on one park database.

Table 4. Fire Ecologist 2011 Accomplishments/Focus Areas

Category	Percent Time	Accomplishments and/or areas of activities
Planning	6%	Determining fire effects travel costs to area parks, training of field crew in FFI
Presentations	5%	Scientific meetings, park staff, public, etc.
NPS Meetings/ task groups	8%	Park, I&M, & FESC meetings; NGP Technical Committee meeting; BADL Climate Change Vulnerability Assessment Working group; Worked on JECA, DETO, and THRO Natural Resource Condition assessments; Fire regime and historical climate data input for the WICA climate change research project
Interagency work	1%	Black Hills Area Ecologist & Botanist Workshop
Wildfire Assignments	0%	Slow fire season!
Prescribed fire projects	3%	FEMO on 6 RX fires (7 operational periods)
Non-fire fuels projects	0%	
Research	10%	Invasive plant species research project – training field crew
Data Collection	12%	Invasive plant species research project – WICA, JECA, and DETO; CBI plot work at WICA
Data entry, check	3%	CBI data entry for American Elk RX; BADL, KNRI, SCBL, & THRO data checking
Data management & analysis	30%	Northern Great Plains area parks fire effects database management and analysis
Supervision/Admin	15%	Hiring, supervision, travel, payroll, etc.
Training	3%	Botany, Supervisory, EEO training, Operational Leadership, MWR/IMR fire ecology workshop
Travel out-of-park for plot or project work	2%	Travel to SCBL, DETO, BADL, & THRO for monitoring and RX fires
Miscellaneous	2%	NGP fire management web site, Writing burn reports

C. Fire effects crew accomplishments and areas of focus

Table 5. Fire Effects Crew 2011 Accomplishments/Focus Areas

Category	Percent Time	Notes
FMH plots	12%	Re-reading of FMH plots (Forest, Grass, and Brush)
NGP Plots	8%	Re-reading of burn-unit specific plots (FFV, GFV, photo points)
I&M Plots	30%	Installing I&M style plots. At JECA/MORU these were installed park-wide. All other parks' installs fell inside active burn units
WUI plots	0%	
CBI plots	5%	Reading 48 CBI plots within the American Elk RX at WICA
Wildfire assignments		Wildfire assignments, including local I.A., details with the Black Hills Wildland Fire Module
Prescribed fire projects	7%	Prescribed fires in the NGP park group, calendar year 2011
Non-fire fuels projects	0%	Estimated amount of time spent assisting with non-fire fuels projects; include mechanical fuel reduction using chainsaws or other, herbicide/mowing, and associated READ activities

Travel out-of-park for plot or project work	4%	Travel to AGFO, SCBL, DETO, BADL, THRO, & KNRI for monitoring and RX fires
Data entry, check	10%	100% of plot data entered & 80% checked in FFI as of 1/17/12
Data analysis	0%	
Supervision/Admin	12%	Travel, payroll, seasonal hiring, field season preparation, equipment upkeep and repair, end of season closeout
Training	8%	Each crewmember had botany training & ATVO training. Additional courses taken by some individuals include S-211, S-234, & S-290.
Miscellaneous	4%	physical training, fuel sampling, herbarium updates.