



**National Park Service
Fire Ecology Annual Report
Calendar Year 2013**

**Colorado Front Range &
Northwest Colorado
Park Clusters**



Big Meadows wildfire, Rocky Mountain National Park, June 11, 2013

A. Summary

New crew lead Chris Kopek (former Fire Effects lead for the Heartland Inventory and Monitoring Network) and new crew member Andy Forget performed a wide variety of tasks throughout the 2013 field season including monitoring activities at Dinosaur National Monument (DINO) and host unit Rocky Mountain National Park (ROMO), wildland fire response both in and out of park, search and rescue efforts at ROMO, and ended the field season conducting stabilization and rehabilitation efforts associated with the record-breaking flood along the Front Range in September. The 2013 fire season got off to an early start for the crew with the Big Meadows fire which started on June 10, just 2 weeks following the completion of pre-season training. Chris and Andy spiked out on Big Meadows as Fire Effects Monitor (FEMO) and FEMO trainee respectively. Nate Williamson continued working as a Long-Term Fire Analyst (LTAN) mentee on Rocky Mountain Area IMT2 Team A during the 2013 fire season (5 incidents), provided fire behavior analysis on his home unit, and resumed his commitment to the Wildland Fire Management Research, Development & Application (WFM RDA) Fire Behavior Specialist call-when-needed list.

The busy 2012 fire season in Colorado generated considerable interest in fire ecology and fire management. Nate led field trips into the Fern Lake fire for local media, The YMCA of the Rockies (adjacent to ROMO and evacuated during the Fern Lake fire), and The Nature

Conservancy. Nate also had the opportunity to represent the park's Fire Management program during a visit from U.S. Representative Jared Polis.

Plot work

DINO 10 Year 30 plot visits

The fire effects monitoring crew resampled monitoring plots associated with the Dry Woman wildfire. The Dry Woman incident was managed as a prescribed natural fire in 1983. Monitoring followed existing non-FMH protocols developed by DINO resource management personnel. Please see Appendix A for an analysis of the Dry Woman data. Additionally, the Black Hills Wildland Fire Module installed 4 transects during the Wild-Hacking Complex. Work continues to input legacy monitoring data from DINO (pre-2003) into the FEAT/FIREMON Integrated (FFI) database; see Appendix B for an analysis of data associated with the 2005 Bighorn Basin prescribed fire.

ROMO 4 Year 05 plot visits
 3 Year 10 plot visits

Year 05 plot visits were conducted in the Front Range Ponderosa Pine (FPIPO1T09) and Ponderosa Savanna (FPIPS1T02) monitoring types following the 2008 prescribed burn in Upper Beaver Meadows. Year 10 plot visits were conducted in the Front Range Ponderosa Pine monitoring type following the 2003 prescribed burns in the South Lateral Moraine East and Beaver Meadows #1 burn units. See Table 3 for management objectives and monitoring results.

Due to the demands of the fire season and flood stabilization efforts, scheduled plotwork at BLCA and MEVE did not occur. See Appendix C for an initial analysis of data associated with the Red Canyon prescribed fire at COLM.

Results of the rare plant survey associated with the Wild Basin Fuels Reduction Project can be found in Appendix D.



Andy, Big Meadows wildfire (ROMO), June 19, 2013

Table 1. Fire Effects Plot Workload (2013) and Total Plots Installed

Park	Monitoring Unit	Type of Plot	Pre-treatment	Immediate Post	Post-treatment (1+ yrs)	Annual Total	Total Plots
Black Canyon of the Gunnison	Green Grizzly	Transect					14
		Total	0	0	0	0	14

Park	Monitoring Unit	Type of Plot	Pre-treatment	Immediate Post	Post-treatment (1+ yrs)	Annual Total	Total Plots
Colorado	Liberty Cap	Transect					7
	Monument Mesa	Transect					2
	Red Canyon	Transect					4
	Ute Mesa	Transect					15
		Total	0	0	0	0	28

Park	Monitoring Unit	Type of Plot	Pre-treatment	Immediate Post	Post-treatment (1+ yrs)	Annual Total	Total Plots
Curecanti	Soap Creek	FMH Forest plot					1
		Photo-point					6
		Total	0	0	0	0	7



Wild-Hacking wildfire (DINO), June 15, 2013

Park	Monitoring Unit	Type of Plot	Pre-treatment	Immediate Post	Post-treatment (1+ yrs)	Annual Total	Total Plots
Dinosaur	Bear Fire	Transect					6
	Bighorn Basin Rx	Transect					10
	Buster Flats	Transect					10
	Chew Basin	Transect					15
	Disappointment Draw	Transect					10
	Dry Woman	Transect			10	10	10
	East Cactus	Transect					10
	Green Mountain Slope	Transect					9
	HQ Housing Area	Modified Daubenmire					5
	Iron Mine Draw	Transect					5
	Iron Springs Bench	Transect					11
	Lower Disaster Falls	Transect					10
	Pearl Park Rx	Transect					10
	Peterson	Transect					6
	Pot Creek	Transect					10
	Ruple Ranch	Transect					8
	Slaugh Wall Rx	Transect					10
	Split Mountain	Age analysis					20
	Success	Transect					9
	Thanksgiving	Transect					8
	Triple C	Transect					9
	West Cactus I	Transect					10
	West Cactus II	Transect					10
	Wild-Hacking	Transect	4	2		6	4
	Zenobia Basin	Transect					8
Total			4	2	10	16	233



Dry Woman wildfire (DINO), burned (left) and unburned (right) transects 30 years post-fire

Park	Monitoring Unit	Type of Plot	Pre-treatment	Immediate Post	Post-treatment (1+ yrs)	Annual Total	Total Plots
Florissant Fossil Beds	Mixed Conifer - Manual Treatment	FMH Forest plot					4
	Mixed Conifer - Manual Treatment	Photo point					70
	Ponderosa Pine	FMH Forest plot					2
	Ponderosa Pine - Manual Treatment	FMH Forest plot					3
	Ponderosa Savanna	FMH Forest plot					3
		Total	0	0	0	0	82

Park	Monitoring Unit	Type of Plot	Pre-treatment	Immediate Post	Post-treatment (1+ yrs)	Annual Total	Total Plots
Great Sand Dunes	Medano WF	CBI					26
	Pinyon Flats HFR	Photo point					7
	San Luis Valley Ponderosa Savanna	FMH Forest plot					6
	San Luis Valley Rabbitbrush Prairie	FMH Brush Plot					19
	San Luis Valley Rabbitbrush Prairie	FMH Forest plot					2
		Total	0	0	0	0	60

Park	Monitoring Unit	Type of Plot	Pre-treatment	Immediate Post	Post-treatment (1+ yrs)	Annual Total	Total Plots
Mesa Verde	Farview	FMH Brush plot					3
	Bobcat Canyon	FMH Forest plot					1
	Upper Navajo	FMH Brush plot					5
		Total	0	0	0	0	9

Park	Monitoring Unit	Type of Plot	Pre-treatment	Immediate Post	Post-treatment (1+ yrs)	Annual Total	Total Plots
Rocky Mountain	Cow Creek WF	CBI					18
	Front Range Ponderosa Pine	FMH Forest plot			6	6	19
	Ponderosa Savanna	FMH Forest plot			1	1	14
	Eastside Lodgepole Pine – Manual Treatment	FMH Forest plot					6
		Photo point					73
	Big/Common Sagebrush	FMH Forest plot					8
	Lower Montane Mixed Conifer	FMH Forest plot					21
		Photo point					3
	Grand Lake HFR	Rapid Assessment					8
	Lodgepole Pine – West Slope	FMH Forest plot					14
	Deer Mtn HFR	Rapid Assessment					12
		Total	0	0	7	7	196

			Pre-treatment	Immediate Post	Post-treatment (1+ yrs)	Annual Total	Total Plots
		Total all Parks	4	2	17	23	629



Big Meadows wildfire(ROMO), June 11, 2013

Table 2. Fire Ecology Staffing 2013

Ecologist and Monitors	Starting Date	Ending Date	# of Pay Periods	READ Qualified	Training and Development
Chris Kopek (lead)	5/6/2013	9/27/2013	10.5	No	80 hours critical training with Alpine IHC; First Aid/CPR; S-211 Refresher; S-212 Refresher; B-3 (Aviation Safety); Defensive Driving; Fire Extinguisher Use; Bloodborne Pathogens; HAZWOPER; <i>OTJ Training:</i> RAWs maintenance, Monitoring techniques, Fuel Moisture Sampling; Data Management; Fire Assignments as FEMO and FFT1 trainee.
Andy Forget	5/6/2013	8/22/2013	8	No	80 hours critical training with Alpine IHC; First Aid/CPR; S-211 Refresher; S-212 Refresher; B-3 (Aviation Safety); Defensive Driving; Fire Extinguisher Use; Bloodborne Pathogens; HAZWOPER; <i>OTJ Training:</i> Monitoring techniques, Fuel Moisture Sampling; Data Management; Fire Assignments as FEMO trainee.
Nate Williamson	1/1/2013	12/31/2013	26	Yes	S-230/231; Supervisory Training; First Aid/CPR; Defensive Driving; Fire Extinguisher Use; Bloodborne Pathogens; Fire Assignments as FFT1, FARS, GSAN, and LTAN mentee.



Andy & Chris, Big Meadows wildfire (ROMO), June 17, 2013

Table 3. 2013 Management Objectives and Monitoring Results

Monitoring Unit	Management Objective	Monitoring Results ($\alpha = 80\%$)	Objective Achieved?	Year Last Analysis Completed (Data Range)
Pearl Park Rx (DINO)	60-100% reduction in sagebrush cover	100% reduction in sagebrush cover ($n=5$; 1 burn)	YES	2011 (2003-2011)
	Increase cover of native grasses to 30% within 2 years post-burn	85% cover of native grasses 2 years post-burn ($n=5$; 1 burn)	YES	2011 (2003-2011)
Dry Woman PNF (DINO)	no specific objectives stated		See Appendix A for an analysis of data	2013 (1984-2013)
Bighorn Basin Rx (DINO)	Improve winter habitat for bighorn sheep Restoration to pre-settlement grassland vegetation		Specific objectives not addressed by monitoring efforts See Appendix B for an analysis of data	2013 (2004-2012)



Fire Management Office (ROMO), April 15, 2013

Monitoring Unit	Management Objective	Monitoring Results ($\alpha = 80\%$)	Objective Achieved?	Year Last Analysis Completed (Data Range)
Front Range Ponderosa Pine (ROMO)	40-80% total fuel reduction	32.5% reduction in total fuel load ($n=9$; 5 burns)	NO <i>Note: when considering woody fuels only, fuels reduction is 31.9%</i>	2012 (1999-2013)
	Limit overstory PIPO mortality to 5% within 5 years post-burn	26.0% reduction in overstory PIPO ($n=9$; 5 burns)	NO , but mountain pine beetle mortality a factor	2013 (1999-2013)
	generate 5-35% mortality in pole-sized trees within 5 years post-burn	49.3% reduction in pole-sized trees ($n=5$; 5 burns)	NO , but mountain pine beetle mortality a factor	2013 (1999-2013)
Ponderosa Savanna (ROMO)	40-80% total fuel reduction	1.3% reduction in total fuel load ($n=10$; 4 burns)	NO (results not significant)	2011 (1998-2011)
	Limit overstory PIPO mortality to 5% within 5 years post-burn	0% reduction in overstory PIPO ($n=5$; 3 burns)	YES	2011 (1998-2011)
	generate 5-30% mortality in pole-sized trees within 5 years post-burn	30.0% reduction in pole-sized trees ($n=5$; 3 burns)	YES	2011 (1998-2011)
Lodgepole Forest Westside (ROMO)	40-80% total fuel reduction	62.1% reduction in total fuel load ($n=4$; 2 burns)	YES (results not significant)	2011 (1998-2003)
	generate 10-45% mortality in overstory trees within 5 years post-burn	0.9% increase in overstory trees ($n=3$; 1 burn)	NO	2011 (1998-2003)
Eastside Lodgepole Pine Manual Treatment (ROMO)	80-100% woody fuel reduction	12.7% reduction in woody fuel load ($n=5$; 1 treatment)	NO (results not significant) <i>Note: when considering woody fuels > 1", fuels reduction is 63.8%</i>	2012 (2001-2012)
		33.6% reduction in overstory trees ($n=5$; 1 treatment)	N/A (objectives not specifically tied to overstory density)	2012 (2001-2012)
		70.2% reduction in pole-sized trees ($n=5$; 1 treatment)	N/A (objectives not specifically tied to pole-sized tree density)	2012 (2001-2012)
Lower Montane Mixed Conifer (ROMO)	40-80% total fuel reduction	50.5% reduction in total fuel load ($n=8$; 2 burns)	YES	2012 (1998-2012)
	generate 10-25% mortality in overstory trees within 5 years post-burn	61.9% reduction in overstory trees ($n=7$; 2 burns)	NO , but mountain pine beetle mortality a factor	2012 (1998-2012)
	generate 10-25% mortality in pole-sized trees within 5 years post-burn	48.2% reduction in pole-sized trees ($n=7$; 2 burns)	NO , but mountain pine beetle mortality a factor	2012 (1998-2012)

B. Fire ecologist accomplishments and areas of focus

Table 4. Fire Ecologist 2013 Accomplishments/Focus Areas

Category	Percent Time	Accomplishments and/or areas of activities
Planning	20%	- Coordinated Fern Lake BAER Plan development - Coordinated Big Meadows BAER Plan development - Development of ROMO Fire/Fuels Treatment Monitoring Plan
Presentations	5%	- Represented Fire Management during meeting with Congressman Jared Polis and Estes Valley Fire Protection District - Fern Lake Fire/Fire Ecology: YMCA of the Rockies - Fern Lake Fire/Fire Ecology: The Nature Conservancy - Fire Ecology/Forest Health: ROMO Interpretive staff - Fire Ecology: Eagle Rock School
NPS Meetings/ task groups	5%	- IMR RAWS Coordinator duties - NPS Fire Weather Committee - IDT member for ROMO Exotic Plant Management EA planning process - Consulted with ROMO and CSU staff on vegetation monitoring - ROMO New Technology Committee member
Interagency work	5%	- Represented NPS as member of Rocky Mountain Area Fire Danger Rating Sub-committee - Assisted in data development/entry/analysis of interagency FPA data - Helped instruct WFDSS workshop for R2 USFS staff - Participated in Rocky Mountain Incident Management Team meetings - Participated in "Parks as Portals to Learning" course with CSU students/staff
Wildfire assignments	20%	- LTAN mentee on RM IMT2A (5 assignments) - Participated in Fern Lake wildfire in a variety of planning-related functions (decision support, PSC) - Participated in Big Meadows wildfire in a variety of planning-related functions (decision support, GSAN) - Local Initial Attack (in park and adjacent State/USFS) as ICT5, FFT1, and FFT2 - Continued commitment to the WFM RDA Fire Behavior Specialist call-when-needed list
Prescribed fire projects	0%	
Non-fire fuels projects	5%	Wild Basin rare plant surveys
Research	5%	- Collaborated with Colorado State University researchers with several proposals for ROMO and GRSA projects - ATR (Agreements Technical Representative) for several projects at ROMO and GRSA
Data collection	<5%	Monitors completed bulk of data collection
Data entry	<5%	Monitors completed bulk of data entry
Data analysis	10%	Completed annual report, continuing analyses of previous season's data
Supervision/Admin	15%	- Hired, supervised, trained monitoring crew, completed evaluations - Developed work schedule, priorities

		• Travel and time paperwork
Training	5%	• S-230/231 (Single Resource/Engine Boss) • Local supervisory training • GIS/GPS training conducted by IMR staff
Travel out-of-park for plot or project work	0%	
Miscellaneous	5%	• GRSA RAWS maintenance, first responder duties • Plans Section Chief on ROMO Type 3 All Hazard Team • Acting FMO duties



Nate, Big Meadows wildfire (ROMO), June 19, 2013

C. Fire effects crew accomplishments and areas of focus

Table 5. Fire Effects Crew 2013 Accomplishments/Focus Areas

Category	Percent Time	Notes
FMH plots	20%	• ROMO
WUI plots	<5%	• ROMO
CBI plots	0%	
Other plot work	20%	• DINO, fire effects plots (non-FMH)
Wildfire assignments	20%	• FFT1 trainee, FEMO trainee, FFT2 assignments
Prescribed fire projects	<5%	
Non-fire fuels projects	<5%	• Wild Basin rare plant surveys
Travel out-of-park for plot or project work	5%	• DINO
Data entry	15%	• Estimated amount of time spent entering data from paper to PC
Data analysis	<5%	
Supervision/Admin	<5%	• Payroll, travel authorization/voucher, etc.
Training	15%	• 80 hours critical training with Alpine IHC • First Aid, CPR • B-3 • S-211, S-212 refreshers • ROMO Backcountry Travel Training
Miscellaneous	5%	• ROMO flood stabilization



Chris, Castle wildfire (Kaibab National Forest), August 10, 2013

D. Additional Program Information

Table 6. Planning - 2013

Park	Does Park have written DFCs? (yes or no)	Date Park-level Monitoring Plan completed (or revised)	Total # of Project- or Community-level Monitoring Plans (not just 2013)	Assisted with how many BAER plans in 2013?
Rocky Mountain National Park	Yes (process based)	2013 (in prep)	0	2
Great Sand Dunes National Park and Preserve	No	2005	0	0
Florissant Fossil Beds National Monument	No	2002	0	0
Dinosaur National Monument	Yes	2005	0	0
Colorado National Monument	Yes	2005	0	0
Black Canyon of the Gunnison National Park	Yes	2006	0	0
Curecanti National Recreation Area	Yes	2006	0	0
Mesa Verde National Park	No	2010 (update of 2003 plan)	0	0

Table 7. Monitoring - 2013

Park	% 2013 Data Entered	% 2013 Data Quality Checked	# Prescribed Fires Monitored *	# Non-fire Fuels Treatments Monitored*	# Wildfires Monitored *	# BAER Treatments Monitored*
Rocky Mountain National Park	90%	90%	3	1	1	0
Great Sand Dunes National Park and Preserve	N/A	N/A	0	0	0	0
Florissant Fossil Beds National Monument	N/A	N/A	0	0	0	0
Dinosaur National Monument	100%	100%	0	0	1	0
Colorado National Monument	N/A	N/A	0	0	0	0
Black Canyon of the Gunnison National Park	N/A	N/A	0	0	0	0
Curecanti National Recreation Area	N/A	N/A	0	0	0	0
Mesa Verde National Park	N/A	N/A	0	0	0	0

* Number of treatment units with treatment effects monitoring conducted. Include pre-burn and post-burn monitoring but not burn-day monitoring.

Table 8. Communicating Results - 2013

Park	# of Project Monitoring Reports completed in 2013	# of Annual meeting(s) with Park staff	# of Formal presentations of results	Do you use Minitab?*
Rocky Mountain National Park	0	1	0	Yes
Great Sand Dunes National Park and Preserve	0	0	0	
Florissant Fossil Beds National Monument	0	0	0	
Dinosaur National Monument	3	0	0	
Colorado National Monument	1	0	0	
Black Canyon of the Gunnison National Park	0	0	0	
Curecanti National Recreation Area	0	0	0	
Mesa Verde National Park	0	0	0	

* This information will help to assess Minitab multi-user license needs.

Additional project monitoring reports are currently in preparation and will be completed throughout the winter and spring.

Table 9. Research - 2013

Park	Are research needs identified in FMP or Monitoring Plan? (yes or no)	# of Proposals Submitted in 2013	# of Proposals Funded in 2013	# of Research Projects Supported in 2013*	Additional Comments
Rocky Mountain National Park	Yes	0	2	2	
Great Sand Dunes National Park and Preserve	Yes	0	1	1	
Florissant Fossil Beds National Monument	Yes	0	0	0	
Dinosaur National Monument	No	0	0	0	
Colorado National Monument	No	0	0	0	
Black Canyon of the Gunnison National Park	Yes	0	0	0	
Curecanti National Recreation Area	Yes	0	0	0	
Mesa Verde National Park	Yes	0	0	0	

*Number of funded research projects, new or ongoing, supported by the fire ecology program including logistical info or support, staffing, etc.

E. 2014 Direction

Direction for 2014 will include continued analysis of data and presentations/discussion with fire and resource management staff regarding the implications of those analyses. As time allows, the fire ecologist will seek out opportunities to share/present data to a variety of audiences (e.g. park staff, school groups, scientific community, etc.).

The fire ecologist will continue to pursue opportunities to complete Firing Boss (FIRB) qualification through prescribed fire and wildfire assignments. This will allow the pursuit of a longer term goal of becoming a fully qualified Long-Term Fire Analyst (LTAN). The fire ecologist will also remain on the Rocky Mountain Area Type 2 Incident Management Team A as an LTAN mentee to gain additional experience in this position. Additionally, the fire ecologist will pursue opportunities to work towards Resource Unit Leader (RESL) in wildland fire as well as Planning Section Chief (PSC) on the ROMO All Hazards Type 3 Incident Management Team.

Pending approval to hire seasonal fire effects monitoring staff, the fire effects monitoring field season will begin in May with monitoring visits currently scheduled for BLCA, COLM, DINO, GRSA, MEVE, and ROMO.



Dry Woman Prescribed Fire Project: Year 12 – Year 30 Dinosaur National Monument

INTRODUCTION

The Dry Woman incident was managed as prescribed natural fire 1983. To investigate the effects of the wildfire, 10 permanent vegetation monitoring transects were established by DINO personnel: 5 transects were located within the perimeter of the burn (experimental) and an additional 5 transects were located outside the perimeter of the burn (control).

According to a previous analysis of data in 1995 by Richard Johnson and Hardin Delafield, data were collected in 1984, 1987, 1990, and 1995 by DINO personnel. ROMO's fire effects monitoring crew resampled the 10 monitoring transects in 2010 and 2013. Unfortunately at the time of this analysis, only data from the 1995, 2010, and 2013 site visits were available.

MONITORING METHODS

Transect data were collected following existing protocols developed by DINO Resource Management personnel. Protocols call for a set of five 100-meter transects to be established both within and outside of the burn unit. Each transect is 100 meters long and read at 1-m intervals. Two readings perpendicular to the transect are taken at each 1-meter interval through an optical device for a total of 200 sample points per transect and 1000 transect points per set of 5 transects.

The optical device consists of a 5X magnifier with a cross-hair and a mirror which reflects an image of the ground through the magnifier. The plant species or substrate intersected by the cross-hair in the reflected image is recorded. Multiple species may be recorded at each sample point; however substrate is only recorded in the absence of vegetation.

Where possible, data were analyzed using 2-sample t-tests with a significance level of 0.05.

RESULTS

Comparison of experimental plots vs. unburned controls

Native grass cover was significantly higher in the unburned transects than in the burned transects for the three post-burn visits for which data were available (see Tables 1, 2 and Figure 1). Needle-and-thread (*Hesperostipa comata*) was the predominant native grass species in both the burned and unburned transects. Conversely, cheatgrass (*Bromus tectorum*) cover was significantly lower in the unburned controls than in the burn unit for all three sampling visits (see Tables 1, 2 and Figure 2). Cheatgrass has become the dominant vegetation within the Dry Woman burn unit.

Native forb cover was higher within the Dry Woman burn unit in years 12 and 27, although the differences were not significant between the burned and unburned transects. However in year 30, native forb cover was significantly higher in the unburned controls than in the burned transects (19.3% and 8.2% cover, respectively). Lesser rushy milkvetch (*Astragalus convallarius*) was the predominant forb found in the unburned transects in all years, yet was not observed in the burned transects.

Not surprisingly, shrub cover was significantly lower in the burn unit relative to the unburned control transects. Sagebrush (*Artemisia tridentata*) was completely absent from the burn unit in year 12 and remains below 2% cover 30 years after treatment. Bare ground was significantly

Appendix A

lower in the burned transects in year 12, but was not significantly different in years 27 and 30. Litter cover was not significantly different between the burned and unburned transects.

Table 1. Average percent cover values for the Dry Woman burn unit (control transects). Mean and standard deviation (in parentheses) are shown.

	Average Percent Cover					
	Native grass	Exotic grass	Native forb	Shrub	Bare Ground	Litter
Control Year 12	15.7 (5.4)	2.9 (0.9)	9.6 (2.1)	24.5 (2.5)	17.7 (3.0)	25.0 (2.0)
Control Year 27	28.1 (0.9)	1.1 (1.2)	29.5 (10.5)	25.6 (4.1)	5.7 (1.6)	20.4 (7.6)
Control Year 30	18.3 (6.0)	2.0 (1.2)	19.3 (5.4)	26.2 (3.2)	16.3 (7.3)	30.1 (7.3)

Table 2. Average percent cover values for the Dry Woman burn unit (experimental transects), 12, 27, and 30 years following burning. Mean and standard deviation (in parentheses) are shown.

	Average Percent Cover					
	Native grass	Exotic grass	Native forb	Shrub	Bare Ground	Litter
Experimental Year 12	5.3 (2.7)	33.3 (5.5)	13.1 (4.1)	2.9 (1.5)	7.9 (1.2)	23.3 (3.3)
Experimental Year 27	13.5 (8.5)	41.6 (13.5)	31.1 (11.6)	1.9 (1.3)	4.3 (1.6)	15.8 (5.6)
Experimental Year 30	7.4 (3.3)	32.9 (8.5)	8.2 (6.2)	1.6 (1.3)	18.9 (3.2)	31.9 (10.4)

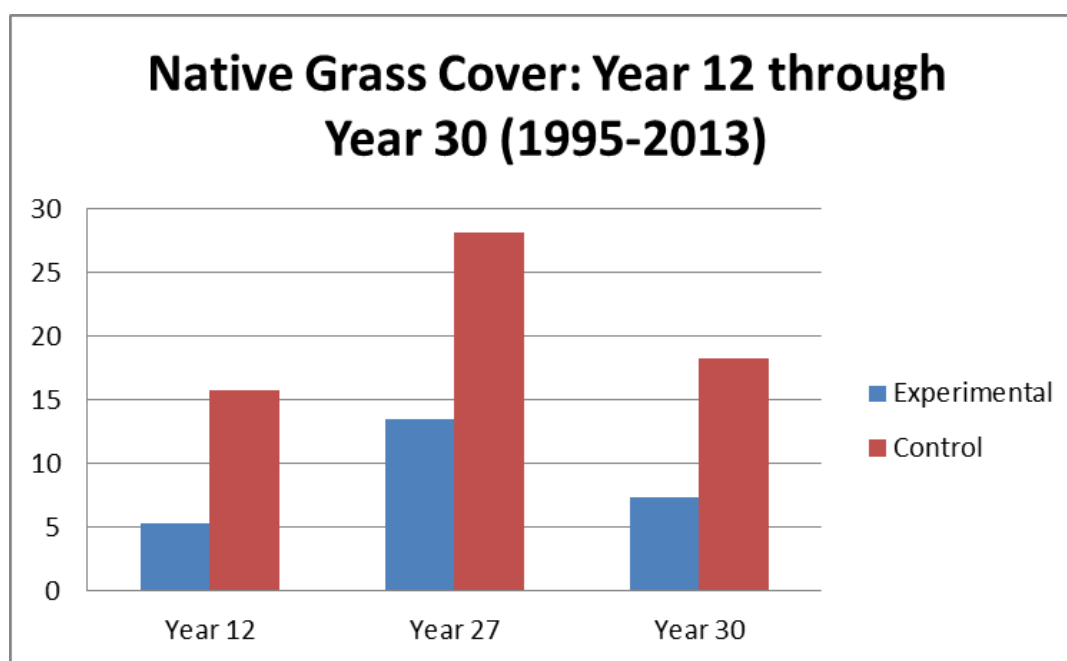


Figure 1. Native grass cover values for the Dry Woman burn unit year 12 through year 30.

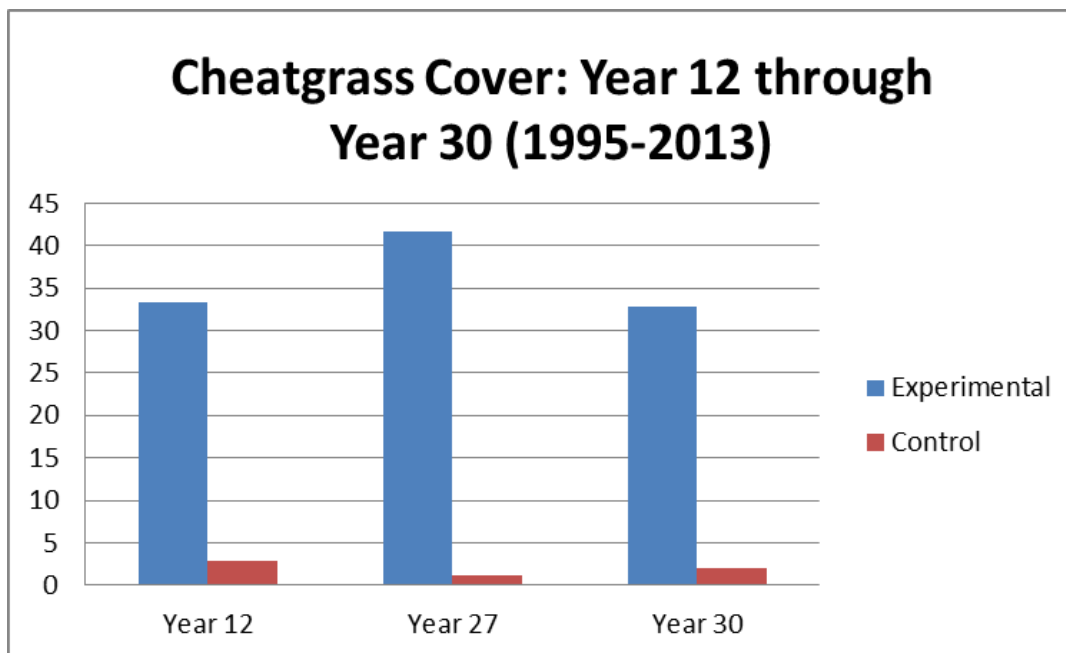


Figure 2. Cheatgrass cover values for the Dry Woman burn unit year 12 through year 30.

DISCUSSION

Although pre-burn data were unavailable at the time of this analysis, the cover and diversity of both native grasses and forbs are higher in the unburned control transects relative to the transects within the Dry Woman burn unit. Additionally, the cover of non-native cheatgrass was much higher within the burned transects for all years which data were available and has become the dominant vegetation within the burn unit.

These plots are scheduled to be sampled again in 2023 (Year 40 following treatment). If sampling data collected prior to 1995 is located, additional analyses will be completed.

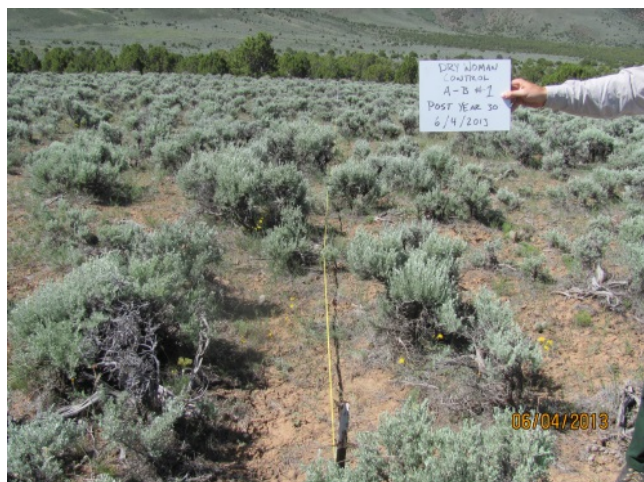


Figure 3. Dry Woman control (unburned) transect #1: June 2013.



Figure 4. Dry Woman experimental (burned) transect #1: June 2013 (30 years post-burn).

Bighorn Basin Prescribed Fire Project: Pre-Burn – Year 7 Dinosaur National Monument

INTRODUCTION

The Bighorn Basin prescribed fire project was treated in 2005. To investigate the effects of the prescribed fire treatment, 10 permanent vegetation monitoring transects were established in June of 2002 by DINO personnel: 5 transects were located within the burn unit (experimental) and an additional 5 transects were located outside the unit (control). ROMO's fire effects monitoring crew resampled the 10 monitoring transects at the following intervals: 1 year, 2 years, 4 years, and 7 years post-burn.

MONITORING METHODS

Transect data were collected following existing protocols developed by DINO Resource Management personnel. Protocols call for a set of five 100-meter transects to be established both within and outside of the burn unit. Each transect is 100 meters long and read at 1-m intervals. Two readings perpendicular to the transect are taken at each 1-meter interval through an optical device for a total of 200 sample points per transect and 1000 transect points per set of 5 transects.

The optical device consists of a 5X magnifier with a cross-hair and a mirror which reflects an image of the ground through the magnifier. The plant species or substrate intersected by the cross-hair in the reflected image is recorded. Multiple species may be recorded at each sample point; however substrate is only recorded in the absence of vegetation.

Comparisons of data from inside and outside the burn unit were analyzed using 2-sample t-tests with a significance level of 0.05. Year to year comparisons of data from either inside or outside the burn unit were analyzed using paired t-tests with a significance level of 0.05.

RESULTS

Native grass cover was significantly higher in post-burn years 1, 2, 4, and 7 in both the treated and untreated transects relative to levels recorded in 2002 (3 years prior to the burn) (see Tables 1 & 2, Figure 1). It should be noted that 2002 was an exceptionally dry year and marked the fourth consecutive year of below average precipitation in the area – drought conditions likely explain the low pre-burn values for native grass cover. With the exception of year 7, native grass cover was similar (not significantly different) between the burned transects and the unburned controls. In year 7 following treatment, native grass cover was significantly higher in the experimental transects relative to the controls (44.7% cover within burn, 28.9% cover out of burn).

Similarly, native forb cover was significantly higher in post-burn years 1, 2, 4, and 7 in both the treated and untreated transects relative to levels recorded in 2002 (see Tables 1 & 2, Figure 2). Prior to burning, native forb cover was 7.3% in the experimental plots and 16.2% in the controls. One year following burning, native forb cover had increased to 14.1% within the burn unit and 42.5% outside the burn area. Again, this dramatic increase probably had more to do with low cover values in 2002 due to the drought than subsequent management activity. By year 7, native forb cover was similar (not significantly different) between the treated and untreated transects (28.0% cover within burn, 33.2% cover out of burn).

In contrast to the native grasses and forbs, non-native grasses [primarily cheatgrass (*Bromus tectorum*), however smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*)

Appendix B

were encountered within the burn unit in years 4 and 7] responded dramatically following burning (see Tables 1 & 2, Figure 3). Non-native grasses were significantly higher in the experimental transects in all years relative to pre-burn levels. Prior to burning, non-native grass cover was 4.7% in the experimental plots and was not encountered in the controls. One year following burning, non-native grass cover had increased to 26.6% cover within the burn unit (an increase of 466%) and to 0.6% cover outside the burn area. Within the burn unit, non-native grass cover increased to a peak of 31.1% cover in year 2, remained essentially unchanged in year 4, and decreased to 8.9% cover in year 7. Outside the burn unit, non-native grass cover remained below 1.2% for all years sampled.

No non-native forbs were encountered in the control transects in any year sampled. Within the burned transects no non-native forbs were encountered prior to the burn. Following the burn, cover of the non-native forb common pepperweed (*Lepidium densiflorum*) was 2.7%. By year 7, the cover of non-native forbs had reduced to 0.3% within the burned transects [species encountered: common pepperweed and salsify (*Tragopogon dubius*)].

Shrubs consisted primarily of big sagebrush (*Artemisia tridentata*), however serviceberry (*Amelanchier alnifolia*), silver sagebrush (*Artemisia cana*), black sagebrush (*Artemisia nova*), deer brush (*Ceanothus velutinus*), little leaf mountain mahogany (*Cercocarpus intricatus*), rabbitbrush (*Chrysothamnus* sp.), broom snakeweed (*Gutierrezia sarothrae*), chokecherry (*Prunus virginiana*), wax currant (*Ribes cereum*), Wood's rose (*Rosa woodsii*), and snowberry (*Symphoricarpos oreophilus*) were also encountered. Shrub cover was similar (not significantly different) inside and outside the burn unit prior to the prescribed fire (27.1% cover within burn, 29.4% cover out of burn, see Tables 1 & 2). Following the burn, shrub cover was reduced significantly to 6.0% (a reduction of 77.8%). By year 7, shrub cover within the burn unit was 12.6% (53.5% lower than pre-burn shrub cover). Although shrub cover varied within the control transects, year 7 values were essentially the same as pre-burn values.

DISCUSSION

Native grass cover was similar in both the burned and unburned transects for all years sampled with the exception of year 7 (native grass cover was significantly higher in the burned transects than the unburned transects in year 7). Native forb cover was higher in the unburned transects than the burned transects for all years sampled. One year after burning the Bighorn Basin unit, shrub cover was reduced 78%. Seven years following fire, shrub cover was 54% lower than pre-burn values. There was essentially no difference in shrub cover in the unburned transects between 2002 and 2012.

One year following burning, non-native grass cover increased by 466% in the experimental transects relative to the initial sampling in 2002 (4.7% cover in 2002, 26.6% cover in year 1). By year 7 non-native grass cover had dropped, but was still nearly twice what it was prior to the burn. In contrast, non-native grass cover in the unburned controls did not exceed 1.2% cover in any year sampled. These plots will be monitored again in 2017 (Year 12 following treatment) and periodically in the future. Figures 4 and 5 are representative of conditions within and adjacent to the Bighorn Basin burn unit 7 years after prescribed fire treatment.

Appendix B

Table 1. Average percent cover values for the Bighorn Basin burn unit pre-burn, 1, 2, 4, and 7 years following burning. Mean and standard deviation (in parentheses) are shown.

	Average Percent Cover					
	Native grass	Exotic grass	Native forb	Shrub	Bare Ground	Litter
Pre-burn	13.1 (3.8)	4.7 (7.3)	7.3 (5.5)	27.1 (6.9)	11.8 (4.0)	22.1 (3.9)
Year 1	25.5 (8.8)	26.6 (34.4)	14.1 (10.8)	6.0 (13.4)	28.8 (17.4)	0.9 (0.8)
Year 2	20.7 (5.0)	31.1 (31.8)	19.9 (16.1)	5.9 (12.9)	10.5 (7.3)	14.6 (4.5)
Year 4	35.9 (8.9)	29.5 (20.75)	22.9 (14.8)	8.0 (14.4)	3.9 (1.3)	11.5 (4.3)
Year 7	44.7 (15.4)	8.9 (8.5)	28.0 (9.1)	12.6 (17.6)	5.5 (1.3)	7.6 (8.5)

Table 2. Average percent cover values for the Bighorn Basin controls (unburned) pre-burn, 1, 2, 4, and 7 years following burning. Mean and standard deviation (in parentheses) are shown.

	Average Percent Cover					
	Native grass	Exotic grass	Native forb	Shrub	Bare Ground	Litter
Pre-burn	11 (3.2)	0	16.2 (5.4)	29.4 (9.6)	18.1 (11.7)	20.1 (6.1)
Year 1	28.9 (8.6)	0.6 (0.9)	42.5 (11.9)	38.3 (7.3)	6.8 (5.6)	3.2 (2.1)
Year 2	22.6 (7.8)	1.1 (1.3)	29.7 (10.3)	22.2 (6.2)	8.4 (7.3)	21.0 (5.3)
Year 4	29.5 (1.3)	1.2 (2.4)	36.4 (6.9)	26.2 (8.9)	7.5 (8.3)	6.5 (2.2)
Year 7	28.9 (9.3)	1.0 (2.0)	33.2 (5.7)	29.5 (10.1)	8.0 (9.1)	5.4 (1.8)

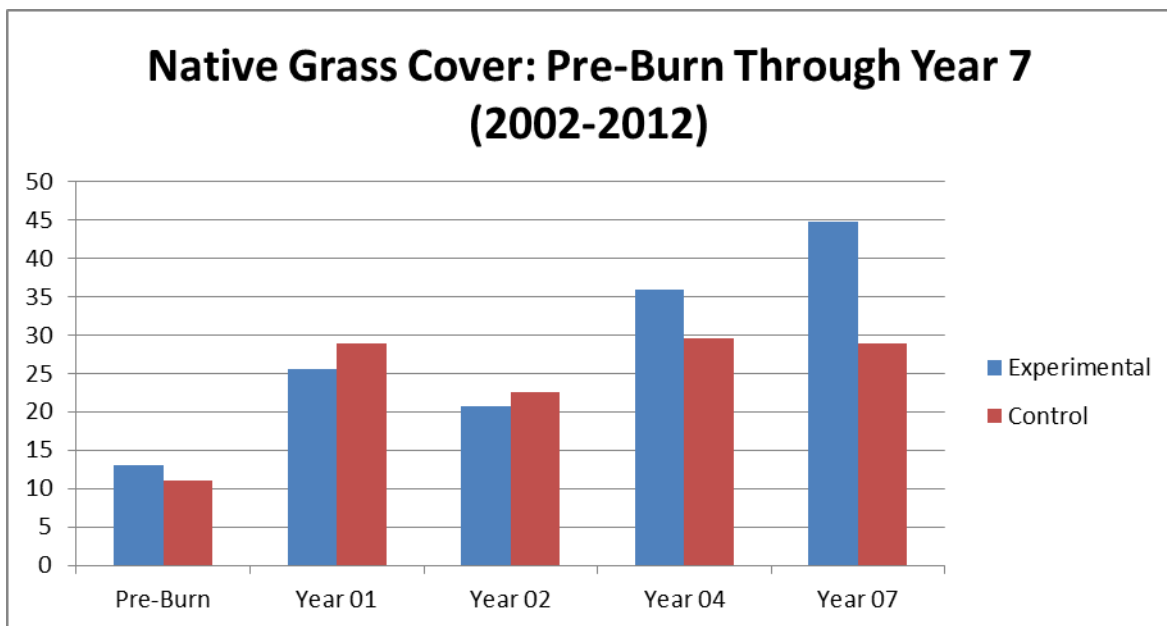


Figure 1. Native grass cover values for the Bighorn Basin burn unit pre-burn through year 7.

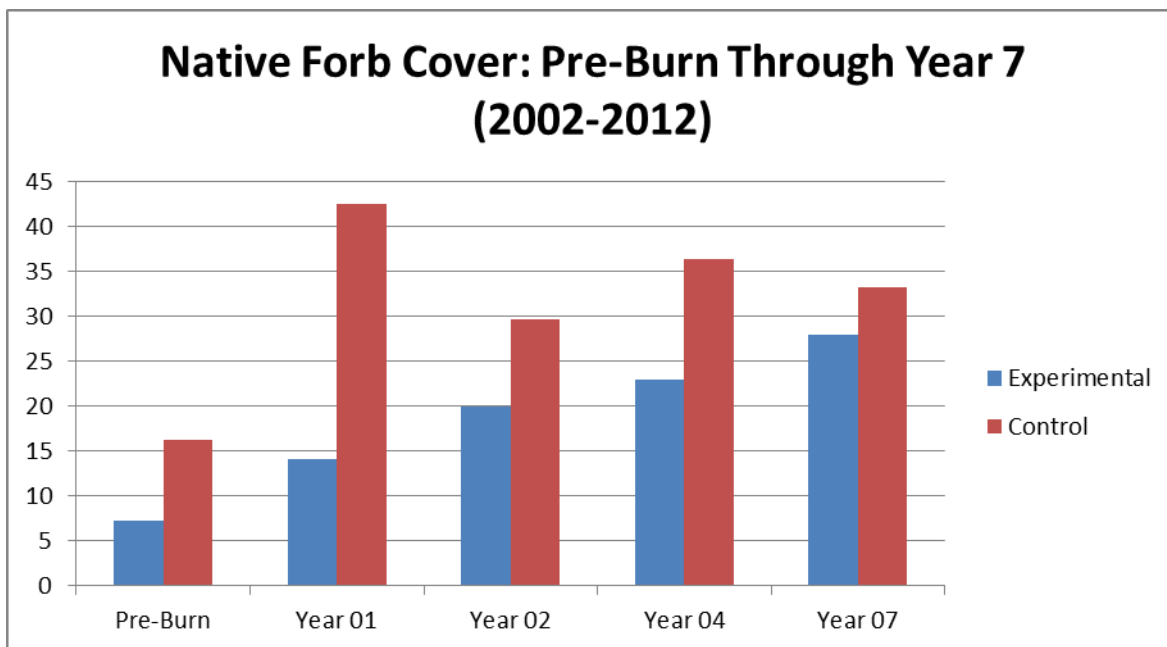


Figure 2. Native forb cover values for the Bighorn Basin burn unit pre-burn through year 7.

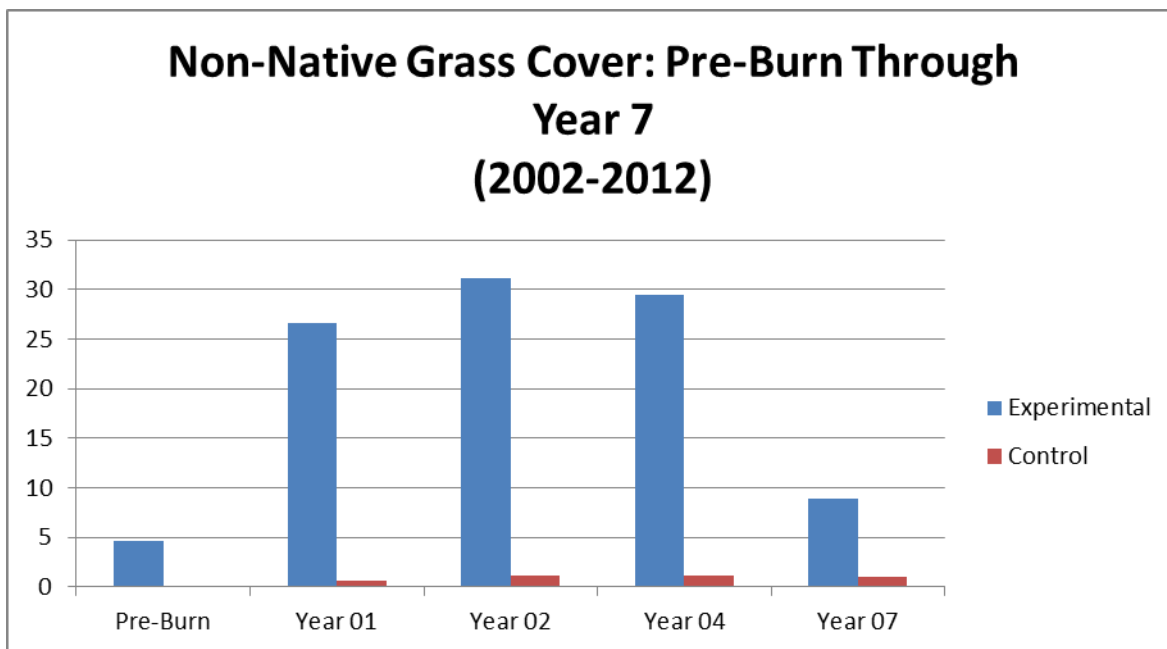


Figure 3. Cheatgrass cover values for the Bighorn Basin burn unit pre-burn through year 7.



Figure 4. Bighorn Basin control (unburned) transect #2: June 2012.



Figure 5. Bighorn Basin experimental (burned) transect #1: June 2012 (7 years post-burn).

Red Canyon Prescribed Fire Project: Pre-Burn – Year 2 Preliminary Results Colorado National Monument

INTRODUCTION

The Red Canyon prescribed fire project was treated in 2010. To investigate the effects of the prescribed fire treatment, 4 permanent vegetation monitoring transects were established by the ROMO fire effects monitoring crew in 2009 prior to treatment. A portion of transects 1 and 2 were burned in the prescribed fire. Transects 3 and 4 were not burned. Data were sampled for the burned transects (transects 1 and 2) in 2009 (pre-burn), 2011 (1 year after treatment), and 2012 (2 years after treatment).

MONITORING METHODS

Transect data collection methods were adapted from existing protocols developed by DINO Resource Management personnel. DINO protocols utilize 100-meter transects read at 1-m intervals however, due to the small size of the treatment units, 50-meter transects were utilized at COLM. Two readings perpendicular to the transect are taken at each 1-meter interval through an optical device for a total of 100 sample points per transect.

The optical device consists of a 5X magnifier with a cross-hair and a mirror which reflects an image of the ground through the magnifier. The plant species or substrate intersected by the cross-hair in the reflected image is recorded. Multiple species may be recorded at each sample point; however substrate is only recorded in the absence of vegetation.

Due to the small sample size (2 transects), no statistical analyses were performed.

RESULTS

The primary native grass present prior to burning was James' galleta (*Pleuraphis jamesii*), [Sandberg bluegrass (*Poa secunda*) was encountered once prior to burning]. One year following burning, native grass cover increased 90% relative to pre-burn values (see Table 1, Figure 1). Two years following burning native grass cover had increased 410% relative to pre-burn values. The number of native grass species present increased from 2 to 8 following burning. The following species were encountered following burning: Indian ricegrass (*Achnatherum hymenoides*), purple threeawn (*Aristida purpurea*), blue grama (*Bouteloua gracilis*), squirreltail (*Elymus elymoides*), needle and thread (*Hesperostipa comata*), and sixweeks fescue (*Vulpia octoflora*) in addition to the 2 species present prior to treatment.

The only non-native grass present prior to burning was cheatgrass (*Bromus tectorum*). One year following burning, non-native grass cover increased 60% relative to pre-burn values and included 1 instance of crested wheatgrass (*Agropyron cristatum*) in addition to cheatgrass (see Table 1, Figure 2). Cheatgrass cover continued to increase 2 years following burning to and was 220% higher than pre-burn values.

Only 1 native forb was encountered prior to burning: scarlet globemallow (*Sphaeralcea coccinea*). One year following burning, native forbs made up 14.5% cover and included Holboell rockcress (*Arabis holboellii*), western tansymustard (*Descurainia pinnata*), rosy gilia (*Gilia sinuata*), and plains mustard (*Schoenocrambe linifolia*) in addition to scarlet globemallow.

Shrub cover was reduced 51% overall on the 2 transects one year following burning (see Table 1, Figure 4). However, as mentioned above, only a portion of the 2 transects was burned. Shrub reduction was much higher in the burned portion of the transects (see Figures 6, 7).

Appendix C

Cover of biological soil crust (Also known as cryptogamic, cryptobiotic, microbiotic, or microphytic soil crusts) was reduced 90% relative to pre-burn values. Two years following burning, it appeared that biological soil crust cover was recovering, but was still well below pre-burn values (see Table 1, Figure 5).

Table 1. Average percent cover values for the Red Canyon burn unit (data from 2 transects).

	Average Percent Cover				
	Native grass	Exotic grass	Native forb	Shrub	Biological soil crust
Pre-burn	5.0	2.5	0.5	35.5	15.0
Year 1	9.5	4.0	14.5	17.5	1.5
Year 2	25.5	8.0	10.0	22.5	5.0

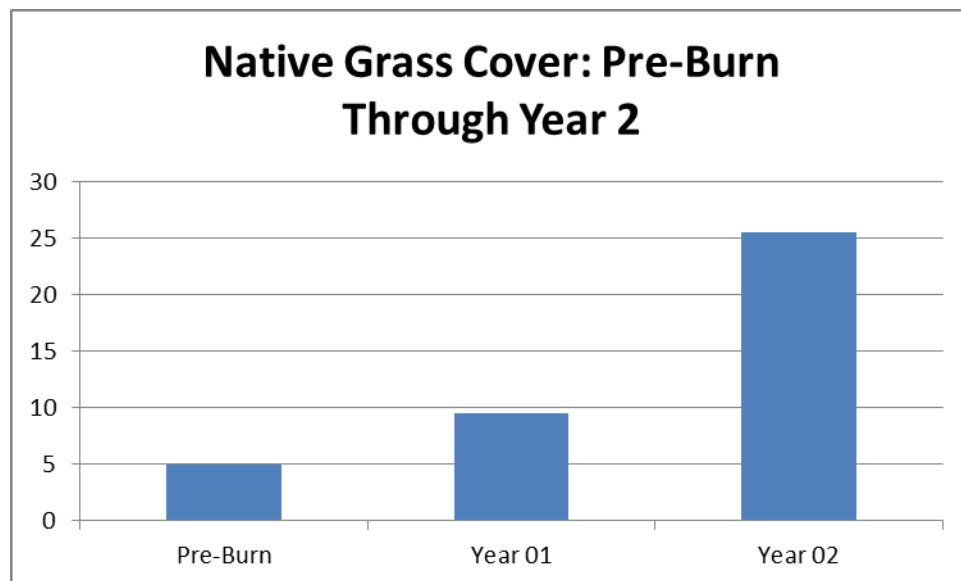


Figure 1. Native grass cover values for the Red Canyon burn unit pre-burn through year 2.

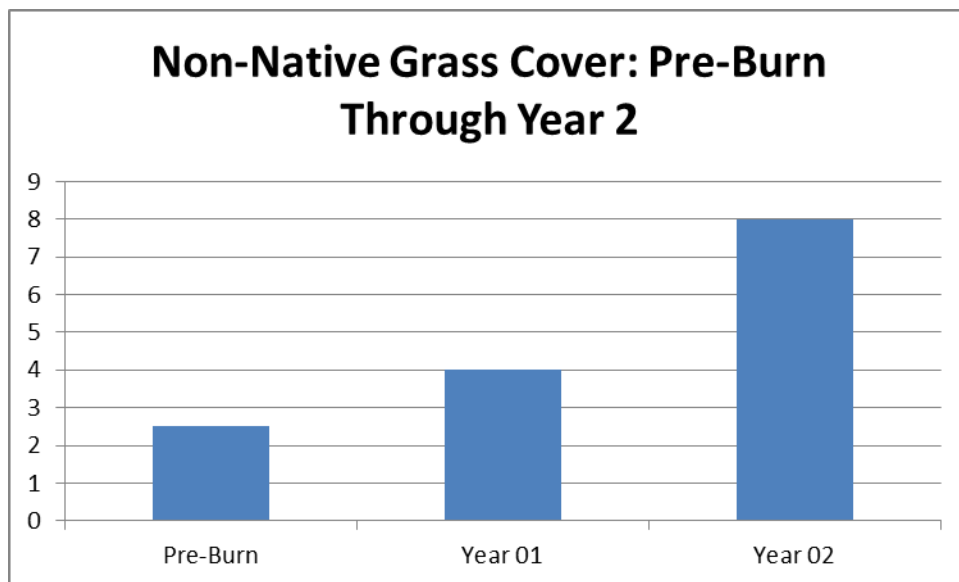


Figure 2. Non-native grass cover values for the Red Canyon burn unit pre-burn through year 2.

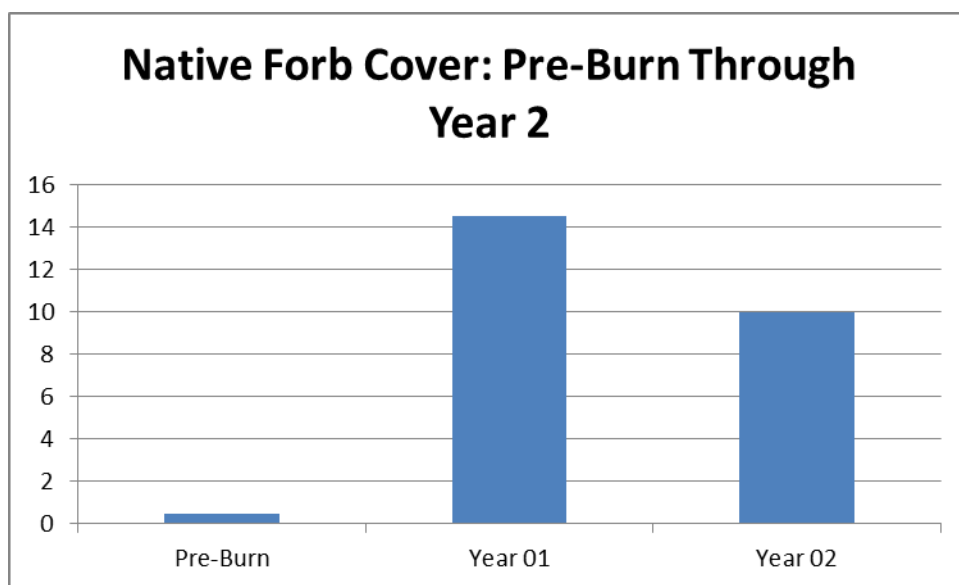


Figure 3. Native forb cover values for the Red Canyon burn unit pre-burn through year 2.

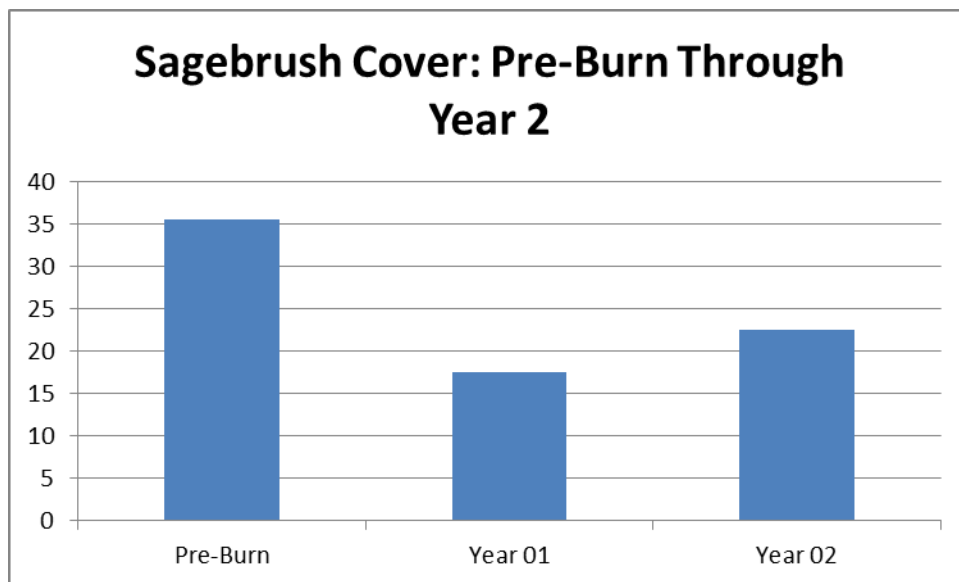


Figure 4. Sagebrush cover values for the Red Canyon burn unit pre-burn through year 2.

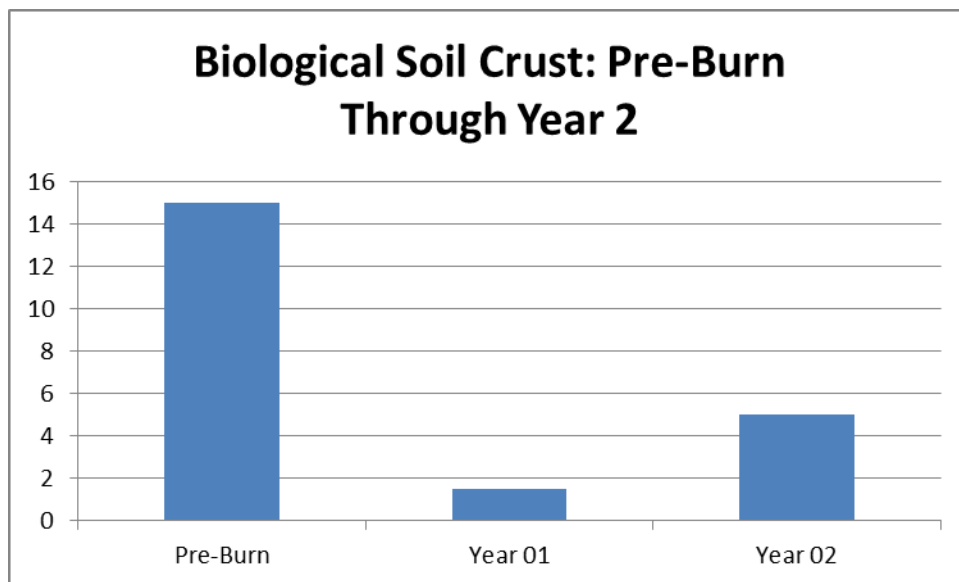


Figure 5. Biological soil crust cover values for the Red Canyon burn unit pre-burn through year 2.

Appendix C

DISCUSSION

The cover and diversity of native grasses and forbs increased in the Red Canyon treatment unit following burning. However, the cover of non-native grasses (predominantly cheatgrass) also increased substantially following treatment. Sagebrush cover was reduced following burning as was the cover of biological soil crust. Two years following treatment, biological soil crust cover had increased over levels recorded 1 year following burning. The recovery of biological soil crusts following burning is dependent on a number of factors including fire intensity and post-fire climatic conditions and can be inhibited by the presence of non-native grasses and forbs.

These transects were scheduled to be sampled again in 2013, however due to the demands of an active fire season, sampling did not occur. Sampling will resume in 2014 as funding allows. Future visits will note the transition of the burned and unburned areas along the transects to better account for the effects of the prescribed fire treatment.



Figure 6. Red Canyon transect #1 (pre-burn): June 2009.



Figure 7. Red Canyon transect #1 (Year 2): August 2012 (transect extends into unburned sagebrush in background).

**Rare Plant Survey Report
Wild Basin Fuels Reduction Project, 2013
Wild Basin, Boulder County, Colorado
September 2013**

Introduction

This report presents the results of plant surveys conducted within sub-units (A, B, C, D) of the Wild Basin Fuels Reduction Project located along the Wild Basin Road in the southeast portion of Rocky Mountain National Park. Total acreage surveyed was approximately 46.2 acres. The purpose of the survey was to determine if any rare plants were present within the fuels treatment area.

The surveys were conducted on August 19, 20, 22, 24, 26, 27, and 28. Surveys were conducted by the Fire Ecologist (Nate Williamson) and/or Fire Effects Monitors (Chris Kopek, Andy Forget). Additional surveyors from the fuels module and forestry crew were utilized on August 19, 20, 26, and 27. These additional surveyors included Mike Donnachie, Will Edwards, John Hussey, Dale Loper, and Jay Schaub.

Rattlesnake plantain (*Goodyera oblongifolia*) and possibly pictureleaf wintergreen (*Pyrola picta*) were found in several locations within sub-units B, C, and D. No other rare plants were encountered during the surveys and no rare plants were encountered within sub-unit A.

Vegetation

Vegetation communities in the Wild Basin Fuels Reduction Project include: Riparian Upper Montane Mixed Conifer, Lodgepole Pine – Low Elevation, Montane Douglas-fir, Upper Montane Aspen, and Herbaceous Upland Montane (Salas et al. 2005).

Riparian Upper Montane Mixed Conifer

This riparian woodland system is comprised of seasonally flooded forests and woodlands found at montane to subalpine elevations. This system contains the conifer and aspen woodlands that line montane streams. These are communities tolerant of periodic flooding and high water tables. Snowmelt moisture in this system may create shallow water tables or seeps for a portion of the growing season. This is confined to specific riparian environments occurring on floodplains or terraces of rivers and streams, in V-shaped, narrow valleys and canyons (where there is cold air drainage). Dominant tree species usually includes subalpine fir (*Abies lasiocarpa*) and/or Engelmann spruce (*Picea engelmannii*); other important species include Douglas-fir (*Pseudotsuga menziesii*), Colorado blue spruce (*Picea pungens*), aspen (*Populus tremuloides*), Rocky Mountain maple (*Acer glabrum*), and Rocky Mountain juniper (*Juniperus scopulorum*). Lodgepole pine (*Pinus contorta*) may also be present, but not usually dominant.

Lodgepole Pine – Low Elevation

This map unit is found in the montane zone within the park. This map unit is defined in part by elevations less than 9500 ft. This is because, generally speaking, *Vaccinium* spp. occurs above this elevation while other lodgepole pine associations occur below 9500 ft. Forests included in this map unit are characterized by a closed to moderately open tree canopy that is dominated

Appendix D

by lodgepole pine. Stands may be even-aged or multi-aged depending on geographic location, edaphic characteristics, and how the stands were established following wildfire. Shrub and herbaceous layers may be present or absent depending on tree canopy. Other tree species such as subalpine fir, Engelmann spruce, or Douglas-fir, may be present to abundant as seedlings and saplings. If these conifers are present they typically have less than 10% cover. Associated shrub and herbaceous species vary for this map unit. Herbaceous cover is typically very sparse. Common subalpine and montane shrub species include kinnikinnick (*Arctostaphylos uva-ursi*), Oregon grape (*Mahonia repens*), bitterbrush (*Purshia tridentata*), buffaloberry (*Shepherdia canadensis*), snowberry (*Symphoricarpos albus*), and currant (*Ribes* spp).

Montane Douglas-fir

Douglas-fir and ponderosa pine (*Pinus ponderosa*) are the most frequent overstory species and ponderosa pine may be codominant. Other conifers such as lodgepole pine subalpine fir, and Engelmann spruce can be found growing in the same occurrence, and there are a number of cold-deciduous shrub and graminoid species common including common juniper (*Juniperus communis*), waxflower (*Jamesia americana*), mountain ninebark (*Physocarpus monogynus*), and Geyer's sedge (*Carex geyeri*).

Upper Montane Aspen

Stands have a somewhat closed to closed canopy of trees from 5-20 m tall that is dominated or codominated by aspen. Several species of conifer trees may also be present in the tree canopy including subalpine fir, Engelmann spruce, Colorado blue spruce, lodgepole pine, ponderosa pine, and Douglas-fir. Conifer species may contribute up to 25% of the tree canopy before the stand is reclassified as a mixed stand. Because of the open growth form of aspen, enough light can penetrate for lush understory development. Common shrubs include Rocky Mountain maple, common juniper (*Juniperus communis*), chokecherry (*Prunus virginiana*), buffaloberry, and whortleberry (*Vaccinium myrtillus*).

Herbaceous Upland Montane

This map unit generally occurs between 8040 and 8845 ft. on flat to rolling plains or lower side slopes that are dry. An occurrence usually consists of a mosaic of two or three plant associations with one of the following dominant bunch grasses: oatgrass (*Danthonia* spp.), mountain muhly (*Muhlenbergia montana*), blue grama (*Bouteloua gracilis*), and Sandberg bluegrass (*Poa secunda*). These small to medium patch grasslands are intermixed with matrix stands of spruce-fir, lodgepole, ponderosa, and various shrub communities.

Methods

Potential occurrence of threatened, endangered, and special concern species in the treatment areas was evaluated by determining which special status species occur in the vicinity of the treatment areas through a literature and database search.

Field Survey

The focused rare plant field surveys were conducted on August 19, 20, 22, 24, 26, 27, and 28, 2013. Field surveys were performed by trained personnel (Fire Ecologist and/or Fire Effects monitors) with additional assistance from the fuels module and forestry crew. Surveys were

Appendix D

floristic in nature. Search effort was focused on inspecting as many of the fine-scale biotic patterns, unusual plant associations and landscape features as possible while still checking some portions of each dominant habitat or plant association. All sites and features with high probability of supporting rare species were investigated. All plants observed were identified using Plants of Rocky Mountain National Park (Beidleman et al. 2000) to the taxonomic level necessary to determine whether or not they were rare. A list of observed plant species is provided in Appendix A.

Results

Rattlesnake plantain (*Goodyera oblongifolia*) and possibly pictureleaf wintergreen (*Pyrola picta*) were found in several locations within sub-units B, C, and D. Both species are considered rare in the park. No other rare plants were encountered during the surveys and no rare plants were encountered within sub-unit A.

Goodyera oblongifolia is a species of orchid native to much of North America. It is most commonly found in mountain forests, often in the understory of conifers. This orchid forms a patch of broad lance-shaped to oval-shaped leaves at the ground, each 4 to 9 centimeters long.

Pyrola picta is a member of the wintergreen family (Pyrolaceae) native to western North America. This plant is a partial parasite and grows in the deep shade of coniferous forests.

Areas containing individuals or patches of *Goodyera oblongifolia* or suspected *Pyrola picta* were identified with multiple strips of blue-white candy stripe flagging. Flagging was hung at least 10 ft. away from each individual plant or patch of plants encountered, marking off areas where treatment activity is to be avoided. No cutting, piling, or dragging of material will occur within the areas marked with blue-white candy stripe flagging.

References

- Beidleman, L.H., R.G. Beidleman, and B.E. Willard. 2000. Plants of Rocky Mountain National Park. Rocky Mountain Nature Association and Falcon Publishing, Inc., Helena, MT.
- Salas, D., J. Stevens, and K. Schultz. 2005. Rocky Mountain National Park, Colorado, 2001-2005 Vegetation Classification and Mapping. Final Report. Technical Memorandum 8260-05-02, US Bureau of Reclamation.

Appendix A. List of Potential Special Status Species within the Survey Area

Family	Lifeform	Scientific Name
Apiaceae	Forb	<i>Aletes humilis</i>
Aspleniaceae	Fern	<i>Asplenium septentrionale</i>
Asteraceae	Forb	<i>Liatris ligulistylis</i>
Cyperaceae	Graminoid	<i>Carex diandra</i>
Cyperaceae	Graminoid	<i>Carex leptalea</i>
Cyperaceae	Graminoid	<i>Carex limosa</i>
Cyperaceae	Graminoid	<i>Carex oreocharis</i>
Cyperaceae	Graminoid	<i>Carex stenoptila</i>
Equisetaceae	Forb	<i>Hippochaete variegata</i>
Iridaceae	Forb	<i>Sisyrinchium pallidum</i>
Juncaceae	Graminoid	<i>Juncus tweedyi</i>
Juncaceae	Graminoid	<i>Juncus vaseyi</i>
Liliaceae	Forb	<i>Lilium philadelphicum</i>
Loasaceae	Forb	<i>Mentzelia sinuata</i>
Lycopodiaceae	Forb	<i>Lycopodium annotinum</i>
Menyanthaceae	Forb	<i>Menyanthes trifoliata</i>
Ophioglossaceae	Forb	<i>Botrychium lunaria</i>
Ophioglossaceae	Forb	<i>Botrychium pinnatum</i>
Ophioglossaceae	Forb	<i>Botrychium 'redbank'</i>
Orchidaceae	Forb	<i>Corallorhiza wisteriana</i>
Orchidaceae	Forb	<i>Cypripedium fasciculatum</i>
Orchidaceae	Forb	<i>Goodyera oblongifolia</i>
Polypodiaceae	Fern	<i>Polypodium hesperium</i>
Polypodiaceae	Fern	<i>Polypodium saximontanum</i>
Portulacaceae	Forb	<i>Erocallis triphylla</i>
Portulacaceae	Forb	<i>Lewisia rediviva</i>
Pyrolaceae	Forb	<i>Pyrola picta</i>
Rosaceae	Forb	<i>Potentilla ambigens</i>
Rosaceae	Forb	<i>Potentilla rupicola</i>
Salicaceae	Shrub	<i>Salix serissima</i>
Saxifragaceae	Forb	<i>Telesonix jamesii</i>
Scrophulariaceae	Forb	<i>Mimulus gemmiparus</i>
Violaceae	Forb	<i>Viola selkirkii</i>

Appendix D

Appendix B. List of Species Observed in Survey Area

Family	Lifeform	Scientific Name	Status
Aceraceae	Shrub	<i>Acer glabrum</i>	Native
Apiaceae	Forb	<i>Conioselinum scopulorum</i>	Native
Apiaceae	Forb	<i>Harbouria trachypleura</i>	Native
Apiaceae	Forb	<i>Heracleum sphondylium</i>	Native
Apiaceae	Forb	<i>Pseudocymopterus montanus</i>	Native
Apocynaceae	Forb	<i>Apocynum androsaemifolium</i>	Native
Asteraceae	Forb	<i>Achillea millefolium</i>	Native
Asteraceae	Forb	<i>Anaphlis margaritacea</i>	Native
Asteraceae	Forb	<i>Antennaria rosea</i>	Native
Asteraceae	Forb	<i>Arnica cordifolia</i>	Native
Asteraceae	Forb	<i>Artemisia ludoviciana</i>	Native
Asteraceae	Forb	<i>Artemisia frigida</i>	Native
Asteraceae	Forb	<i>Bahia dissecta</i>	Native
Asteraceae	Forb	<i>Breea arvensis</i>	Native
Asteraceae	Forb	<i>Chlorocrepis albiflora</i>	Native
Asteraceae	Forb	<i>Erigeron speciosus</i>	Native
Asteraceae	Forb	<i>Gaillardia aristata</i>	Native
Asteraceae	Forb	<i>Heterotheca villosa</i>	Native
Asteraceae	Forb	<i>Machaeranthera pattersonii</i>	Native
Asteraceae	Forb	<i>Packera fendleri</i>	Native
Asteraceae	Forb	<i>Rudbeckia ampla</i>	Native
Asteraceae	Forb	<i>Solidago missouriensis</i>	Native
Asteraceae	Forb	<i>Taraxacum officinalis</i>	Introduced
Asteraceae	Shrub	<i>Artemisia tridentata</i>	Native
Berberidaceae	Shrub	<i>Mahonia repens</i>	Native
Betulaceae	Tree	<i>Alnus incana</i>	Native
Betulaceae	Tree	<i>Betula fontinalis</i>	Native
Brassicaceae	Forb	<i>Arabis fendleri</i>	Native
Brassicaceae	Forb	<i>Erysimum capitatum</i>	Native
Campanulaceae	Forb	<i>Campanula rotundifolia</i>	Native
Caprifoliaceae	Shrub	<i>Sambucus microbotrys</i>	Native
Caprifoliaceae	Shrub	<i>Symphoricarpos rotundifolius</i>	Native
Caprifoliaceae	Shrub	<i>Viburnum edule</i>	Native
Caryophyllaceae	Forb	<i>Silene hallii</i>	Native
Crassulaceae	Forb	<i>Sedum lanceolatum</i>	Native
Cupressaceae	Shrub	<i>Juniperus communis</i>	Native
Dennstaedtiaceae	Fern	<i>Pteridium aquilinum</i>	Native
Elaeagnaceae	Shrub	<i>Shepherdia canadensis</i>	Native
Equisetaceae	Forb	<i>Equisetum arvense</i>	Native
Ericaceae	Shrub	<i>Arctostaphylos uva-ursi</i>	Native

Appendix D

Family	Lifeform	Scientific Name	Status
Ericaceae	Shrub	<i>Vaccinium sp.</i>	Native
Fabaceae	Forb	<i>Astragalus parryi</i>	Native
Fabaceae	Forb	<i>Thermopsis divaricarpa</i>	Native
Fabaceae	Forb	<i>Trifolium repens</i>	Introduced
Gentianaceae	Forb	<i>Frasera speciosa</i>	Native
Geraniaceae	Forb	<i>geranium caespitosum</i>	Native
Grossulariaceae	Shrub	<i>Ribes cereum</i>	Native
Grossulariaceae	Shrub	<i>Ribes montigenum</i>	Native
Hydrangeaceae	Shrub	<i>Jamesia americana</i>	Native
Liliaceae	Forb	<i>Allium cernuum</i>	Native
Liliaceae	Forb	<i>Calochortus gunnisonii</i>	Native
Liliaceae	Forb	<i>Maianthemum amplexicaule</i>	Native
Liliaceae	Forb	<i>Maianthemum stellatum</i>	Native
Liliaceae	Forb	<i>Streptopus fassettii</i>	Native
Monotropaceae	Forb	<i>Pterospora andromedea</i>	Native
Onagraceae	Forb	<i>Chamerion danielsii</i>	Native
Onagraceae	Forb	<i>Gayophytum diffusum</i>	Native
Orchidaceae	Forb	<i>Corallorhiza maculata</i>	Native
Orchidaceae	Forb	<i>Goodyera oblongifolia</i>	Native
Pinaceae	Tree	<i>Abies lasiocarpa</i>	Native
Pinaceae	Tree	<i>Picea engelmannii</i>	Native
Pinaceae	Tree	<i>Pinus contorta</i>	Native
Pinaceae	Tree	<i>Pinus flexilis</i>	Native
Pinaceae	Tree	<i>Pinus ponderosa</i>	Native
Pinaceae	Tree	<i>Pseudotsuga menziesii</i>	Native
Poaceae	Graminoid	<i>Elymus elymoides</i>	Native
Poaceae	Graminoid	<i>Festuca sp.</i>	Native
Poaceae	Graminoid	<i>Hesperostipa comata</i>	Native
Poaceae	Graminoid	<i>Koeleria macrantha</i>	Native
Poaceae	Graminoid	<i>Leucopoa kingii</i>	Native
Poaceae	Graminoid	<i>Muhlenbergia montana</i>	Native
Poaceae	Graminoid	<i>Pascopyrum smithii</i>	Native
Poaceae	Graminoid	<i>Phleum pratense</i>	Introduced
Polygonaceae	Forb	<i>Eriogonum umbellatum</i>	Native
Pyrolaceae	Forb	<i>Chimaphilia umbellata</i>	Native
Pyrolaceae	Forb	<i>Pyrola chlorantha</i>	Native
Ranunculaceae	Forb	<i>Clematis ligusticifolia</i>	Native
Ranunculaceae	Forb	<i>Pulsatilla patens</i>	Native
Ranunculaceae	Forb	<i>Thalictrum fendleri</i>	Native
Rhamnaceae	Shrub	<i>Ceanothus fendleri</i>	Native
Rhamnaceae	Shrub	<i>Ceanothus velutinus</i>	Native
Rosaceae	Forb	<i>Drymocallis fissa</i>	Native

Appendix D

Family	Lifeform	Scientific Name	Status
Rosaceae	Forb	<i>Fragaria vesca</i>	Native
Rosaceae	Forb	<i>Potentilla hippiana</i>	Native
Rosaceae	Shrub	<i>Amelanchier alnifolia</i>	Native
Rosaceae	Shrub	<i>Oreobatus deliciosus</i>	Native
Rosaceae	Shrub	<i>Prunus virginiana</i>	Native
Rosaceae	Shrub	<i>Rosa woodsii</i>	Native
Rubiaceae	Forb	<i>Galium septentrionale</i>	Native
Salicaceae	Tree	<i>Populus angustifolia</i>	Native
Salicaceae	Tree	<i>Populus tremuloides</i>	Native
Saxifragaceae	Forb	<i>Heuchera bracteata</i>	Native
Scrophulariaceae	Forb	<i>Castilleja flava</i>	Native
Scrophulariaceae	Forb	<i>Orthocarpus luteus</i>	Native
Scrophulariaceae	Forb	<i>Pedicularis procera</i>	Native
Scrophulariaceae	Forb	<i>Penstemon virens</i>	Native
Scrophulariaceae	Forb	<i>Penstemon whippleanus</i>	Native