

Grand Teton National Park

2004 Fire Effects Annual Report



Bison have discovered the grass regrowth at the 2003 Blacktail Fire

Summary

The Fire Effects program at Grand Teton National Park is part of an interagency fire management organization in partnership with the USFS Bridger-Teton National Forest. All levels of fire and fuels project monitoring, from reconnaissance to long term vegetation plots, to data analysis, are provided to both agencies. The State of Wyoming Game & Fish Department also works closely with the fire effects program to promote and evaluate habitat improvement projects on federal lands.

2004 was the seventh season for the Grand Teton National Park Fire Effects crew. Four seasonal biological technicians (Stu Osbrack, Clint Foster, Sarah Long, and Kate Cueno) assisted Diane Abendroth in collecting vegetation and fuels data. All were first-year fire effects monitors. In addition, the crew was very fortunate to have assistance from a Forest Service volunteer (Lydia Dixon), as well as habitat biologists from the Wyoming Game & Fish Department (Jill Miller and Jared Rogerson).

In 2004, eight new permanent plots were installed, including two in Grand Teton National Park, and six on the Bridger-Teton National Forest. The crew reread 45 permanent plots this season, and removed rebar and tree tags from eight high-elevation whitebark pine FMH plots in the park to reduce conflicts with wilderness values. Photopoints were installed and re-taken on three fires and two prescribed burns. Over 60 pre-treatment Brown's transects were conducted for mechanical thinning projects.

Few traditional FMH plots have been installed this year. This is due to increased pilot sampling of alternative vegetation monitoring methods, which will hopefully provide more definitive results targeting project objectives that require large sample sizes, such as tree seedling and pole density. A summary of some of these trials is included in this report. As new monitoring protocols are developed, the existing FMH plots will continue to be reread for post burn data collection.

This year's burn severity ground truthing was conducted on the 2003 East Table fire on the Bridger-Teton National Forest (60 CBI plots) and the 2003 Blacktail fire on Grand Teton National Park (47 CBI plots). Fall weather did not permit field work on the 2003 Moss Ridge complex, which was postponed until next year.

Since 2002, Grand Teton National Park has undertaken a comprehensive vegetation mapping and classification project as part of the NPS Inventory and Monitoring Program. The Fire Effects Crew assisted with this data collection for several weeks in 2004. Funding for this project has been contributed by Fire Management, to expedite the mapping. In addition, Fire Management has coordinated the collection of detailed fuels data that will be used to develop models to predict fire behavior.

Table 1. Fire Ecology Staffing 2004

Monitor	Starting Date	Ending Date	# of Pay Periods	Training and Development
Diane Abendroth, Lead Monitor, GS-7 FTE	1/1/04	12/31/04	26	S-244, FFT1 and FEMO taskbooks completed
Stu Osbrack, Crew Lead, GS-6 seasonal	5/10/04	9/30/04	9.5	S-244
Sarah Long, Crew Member, GS-5 seasonal	5/24/03	9/30/04	8.5	S-244, FEMO taskbook initiated
Clint Foster, Crew Member, GS-5 seasonal	5/24/03	10/16/04	10.5	S-244, S-290, FEMO taskbook initiated
Kate Cueno, Crew Member, GS-5 seasonal	6/14/04	10/16/04	9	New FFT2, S-290

Table 2. Fire Effects 2004 Plot Summary

Park	Monitoring Unit	Type of Plot (FMH, photo point, other)	Pre- burn	Imm. Post	Postburn (1-20 yrs)	Total Plots
Grand Teton	Sagebrush steppe	FMH forest plot	2	0	10	28
	Aspen – mixed conifer	FMH forest plot	0	0	9	15
	Lodgepole pine – mixed conifer	FMH forest plot	0	0	5	10
	Douglas fir – mixed conifer	FMH forest plot	0	0	1	10
	Smooth brome meadow	FMH brush plot	0	0	12	18
	Englemann spruce	FMH forest plot	0	0	2	2
	Whitebark pine	FMH forest plot	0	0	0	8
	Willow	FMH grass plot	0	0	0	10
	Bitterbrush	Non-permanent circular plots			X	X
	Sagebrush	Non-permanent circular plots	X	0	0	X
	Aspen	Non-permanent circular browse plots	0	0	X	X
	Sagebrush	CBI		47		47
	Misc.	Permanent photopoint	2	0	9	17
	Mixed Conifer	Brown's transects	69	0	0	69
Bridger- Teton NF	Aspen – Mixed Conifer	FMH Forest plot	0	0	0	7
	Sagebrush – Snowberry	FMH Forest plot	0	0	0	3
	Bitterbrush	FMH Brush plot	0	0	6	6
	Aspen	BFH Macroplot	0	0	0	4
	Sagebrush - Bitterbrush	BFH Macroplot	0	0	11	16
	Willow	BFH Macroplot	2	0	2	6
	Mixed Conifer	Brown's transects	43	0	0	43
	Mixed Conifer	Common Stand Exam	10	0	0	10
	Aspen	Non-permanent circular plots	X	0	0	X
	Aspen	Non-permanent circular browse plots	X	0	X	X
	Misc.	CBI		60		60
	Misc.	Permanent photopoint	11	8	0	19
Bighorn Canyon NRA	Greasewood - Saltgrass	FMH Brush plot	0	0	4	4
	Juniper woodland	FMH Brush plot	0	0	0	12
Totals			139 + X	115	71 + X	424 +X

Data Analysis and Transfer for Adaptive Management

Fire effects data from 1998-2003 were analyzed and presented to an interagency audience of fire managers in February at the second annual Teton Interagency Fire Effects Symposium held in Jackson. This one-day workshop was coordinated by Grand Teton National Park and the Bridger-Teton National Forest, and included presentations from the USFWS National Elk Refuge, the Teton Science School, and the Wyoming Game & Fish Department.

The six-year fire effects summary report presented by Grand Teton National Park included results from prescribed burns in sagebrush, aspen, lodgepole pine, agricultural grasslands, and Douglas fir. While important trends were observed, much of the data did not show statistically significant conclusions. Consequently, the fire effects program is undertaking adaptive responses to develop alternative monitoring methods that meet this need. In 2004, new protocols for determining shrub density and aspen regeneration success were demonstrated. These proved to be efficient and successful. See section entitled "New Innovations."

The Teton Interagency fire effects program has also begun to customize monitoring protocols for individual treatment projects to some extent, rather than relying only on programmatic monitoring. This allows statistically valid conclusions to be drawn about whether or not objectives were achieved on individual projects. These conclusions can then be compared to burn prescription windows, weather and fire behavior data, and immediate post fire effects. In order to monitor individual projects in this way, a monitoring plan outlining measurable objectives, chosen data collection strategies, and follow-up schedules is included in each burn plan or fuels treatment plan. While this requires additional planning at the project level and more complicated crew scheduling, it is valuable to be able to collect conclusive data about the effectiveness of each project. This data will provide concrete and specific information for adaptive management.

The Fire Effects Assessment Tool (FEAT) is not yet up and running at Grand Teton National Park, and data from the former FMH computer program has not yet been converted. The phase-in of FEAT will take place in 2005.

Table 3. Management Objectives and Monitoring Results 2003-2004

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (XX% confidence interval)	Objective Achieved?
Sagebrush Steppe	<i>In the burned portion, reduce total live sagebrush density and cover by a minimum of 60%.</i>	<i>Sagebrush density reduction objectives (40-60% decrease) were exceeded on most burns. Sample error is large when burn units are analyzed separately.</i> <i>Sagebrush cover reduction also exceeds the objective (40-60% decrease) on some burns. Low severity burns were less conclusive, with highly variable data due to patchy treatment.</i>	YES <i>Minimum sample size not achieved</i>
	<i>Increase post fire native grass cover by at least 25%. Increase forb percent cover and species diversity by at least 10% two years post burn.</i>	<i>Even with all burn units combined, both native grass and native forb cover data shows no significant differences pre and post burn.</i> <i>Forb diversity data analysis is still pending. Methods considered include: Indices of species and abundance? Control plots?</i>	NO <i>Minimum sample size not achieved</i>
	<i>Blacken 40-60% of the target area. (Resource Mgmt. Burns)</i> <i>Blacken 60-80% of the target area (Hazard Fuels Burns)</i>	<i>Burn mosaic (% black) estimates vary, as do the objectives.</i>	YES <i>Estimates only</i>
	<i>In the burned portion, obtain a post fire severity rating of "3" or less on plot transects.</i>	<i>All 5 Wolff Ridge plots met severity objectives. Only one of 4 Kelly plots did.</i>	YES and NO <i>depending on burn unit</i>

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (XX% confidence interval)	Objective Achieved?
Aspen - Mixed Conifer	<i>Reduce conifer invasion (pole and seedling density) by at least 60% within 2 years post burn.</i>	<i>Conifer seedling and pole reductions cannot be evaluated using the current plot methods. Samples are too small and variable.</i>	UNKNOWN <i>Minimum sample size not achieved</i>
	<i>Increase aspen seedling density by at least 30% two years post burn.</i>	<i>Aspen regeneration data is highly variable but indicates more than 30% increases are occurring 1 year post burn, but dropping off in year 2. Total resprout densities are low overall (< 5000 stems per acre).</i>	YES <i>Minimum sample size not achieved</i>
	<i>Recruit pole size aspen density of at least 2000 stems per acre ten years post burn.</i>	<i>Only 5 year data is available. Tallest aspen are too sparse now according to 4 plots.</i>	UNKNOWN <i>minimum sample size not achieved</i>
	<i>Maintain dead and down fuel loading at ten tons per acre or less.</i>	<i>Fuel loading was reduced by 23% but still exceeds objective of 10 tons per acre.</i>	NO <i>Minimum sample size not achieved</i>
Lodgepole Pine – Mixed Conifer	<i>Reduce understory pole and seedling density by 40-60% within two years post burn.</i>	<i>Pole and seedling data is far too variable for interpretation.</i>	UNKNOWN <i>minimum sample size not achieved</i>
	<i>Reduce lodgepole pine live overstory tree density by 20-80%</i>	<i>Overstory tree density decreased 21.7%. Data is not significant – more plots are needed.</i>	YES <i>Minimum sample size not achieved</i>
	<i>Reduce total fuel load by 40-60% one year post burn</i>	<i>Data does not indicate a significant difference with 16 total 50 ft. Brown's transects.</i>	NO <i>Minimum sample size not achieved</i>

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (XX% confidence interval)	Objective Achieved?
Douglas Fir – Mixed Conifer	<i>Reduce pole tree density by 10 - 20% within two years post burn.</i>	<i>For the 2 burned plots, pole and seedling tree reductions exceeded objectives. More plots are needed.</i>	YES <i>Minimum sample size not achieved</i>
	<i>Limit the reduction/mortality of 50+cm dbh overstory trees to <20% within two years post burn.</i>	<i>Large overstory tree density data for only 2 plots is not useful. Another method is probably needed.</i>	UNKNOWN <i>Minimum sample size not achieved</i>
	<i>Reduce total fuel load by 40-80% 1 year post burn.</i>	<i>Fuel loading did not decrease as much as desired. Data does not indicate a significant difference with 8 Brown's transects.</i>	NO <i>Minimum sample size not achieved</i>
Smooth Brome Meadow	<i>Increase productivity of grasses within the project area (increase height and percent cover by 25%)</i>	<i>Grass cover and height decreased 1 year post burn and increased 2 years post burn. Control plots would help determine weather influences.</i>	UNKNOWN <i>Seasonal moisture influences may overshadow fire effects</i>
	<i>Where possible increase percent cover of native herbs and density of native shrubs.</i>	<i>Very few native plants are found in this type. Cover data is inconclusive.</i>	UNKNOWN <i>Minimum sample size not achieved</i>
	<i>Redistribute concentrations of Bison from current high use areas into project areas post burn. Increase Bison radio collar locations within the burn units by 60% or greater within the first growing season post burn.</i>	<i>Bison radio collar locations within the burn showed a significant increase</i>	YES

Administrative Accomplishments

Fire Management Plan writing: Grand Teton National Park has revised its fire management plan during 2004. All PFT fire personnel participated in writing the plan and its associated Environmental Assessment. The lead fire effects monitor researched the fire ecology of the park's nine general vegetation types and developed desired future conditions for each. A preliminary assessment of fire regime condition class was also provided for the EA. The new fire management plan will include, as an appendix, a fuels and fire effects monitoring plan. This

document is still in draft. Table 4 shows a summary of the monitoring variables that will be stipulated for prescribed fire, mechanical thinning, wildland fire use, suppression fires in the park.

Table 4. Fuels and Fire Effects Monitoring Variables for Grand Teton National Park.

PROJECT TYPE	LEVEL I Pre-Treatment (Reconnaissance) *=-forested #=-shrub/grassland \$=optional	LEVEL II During Implementation Monitoring *=-forested #=-shrub/grassland \$=optional	LEVEL III Immediate post Implementation (First Order Effects) *=-forested #=-shrub/grassland \$=optional	LEVEL IV Long term monitoring (Second Order Effects) *=-forested #=-shrub/grassland \$=optional
Prescribed Burning for Fuels or Vegetation Management	FRCC determination Fuel loading* Project map Photo documentation Live fuel moisture Pre-monitoring for Level III and IV variables	Fire behavior Flame length Rate of spread Weather Relative humidity Air temperature Wind Smoke Live fuel moisture	Map of burn extent Burn severity map Fuel loading* Photo documentation	FRCC stand determination Fuel loading* Tree canopy cover* Overstory tree density* Overstory tree dimensions (height, DBH, crown ratio, height to live crown, live/dead status)* Overstory tree damage* Pole tree density* Pole tree DBH* Seedling tree density* Seedling tree height* Seedling tree browse (aspen)# Shrub Density# Shrub Canopy Cover# Herbaceous species composition#* Herbaceous canopy cover or frequency#* Ground Cover#
Mechanical Treatments for Natural Scene Restoration / Protection and Hazard Tree removal	Photo documentation Map of project	Tree spacing	Photo documentation Map of project extent	Photo documentation\$
Mechanical treatments for Hazard Fuels in Forested Wildland Urban Interface areas	Photo documentation with sightability board Map of project Fuel loading Pre-monitoring for Level III and IV variables	Tree spacing Photo documentation before piles are burned	Photo documentation Map of project extent Fuel loading Tree Canopy cover Overstory tree BA Overstory tree dimensions (height, DBH, Crown ratio, height to live crown) OS tree damage Pole tree density Pole tree DBH Seedling tree density Seedling tree height Sightability	Photo documentation at 5 year intervals Fuel loading Tree Canopy cover Overstory tree BA Overstory tree dimensions (height, DBH, Crown ratio, height to live crown, live/dead status) OS tree damage Pole tree density Pole tree DBH Seedling tree density Seedling tree height Sightability Herbaceous species composition (weeds)\$

PROJECT TYPE	LEVEL I Pre-Treatment (Reconnaissance) *=forested #=shrub/grassland \$=optional	LEVEL II During Implementation Monitoring *=forested #=shrub/grassland \$=optional	LEVEL III Immediate post Implementation (First Order Effects) *=forested #=shrub/grassland \$=optional	LEVEL IV Long term monitoring (Second Order Effects) *=forested #=shrub/grassland \$=optional
Mechanical treatments in shrub / grassland WUI areas	Photo documentation Map of project		Photo documentation Map of project extent	Photo documentation\$ Herbaceous species composition (weeds)\$
Wildland Fire Use for Resource Benefit	Vegetation map Fuels map\$ FARSITE projection\$ Pre-monitoring for Level III and IV variables if possible\$	Fire growth Fire behavior Flame length Rate of spread Weather Relative humidity Air temperature Wind Smoke Live fuel moisture	Map of fire extent Burn severity map (large fires) Photo documentation\$	<u>For large fires:</u> FRCC stand determination\$ Fuel loading\$ Fuels map revision Vegetation map revision Tree canopy cover\$ Overstory tree density\$ Overstory tree dimensions (height, DBH, Crown ratio, height to live crown live/dead status)\$ OS tree damage\$ Pole tree density\$ Pole tree DBH\$ Seedling tree density\$ Seedling tree height\$ Seedling tree browse (aspen)\$ Shrub Density\$ Shrub Canopy Cover\$ Herbaceous species composition\$ Herbaceous canopy cover or frequency\$ Ground Cover\$
Wildland fire – Suppression Action	Fuels map\$ FARSITE projection\$	<u>For large fires:</u> Fire growth Fire behavior Flame length Rate of spread Weather Relative humidity Air temperature Wind Smoke (visibility) Fuel moisture	Map of fire extent Burn Severity Map (large fires)\$ Photo documentation\$	<u>For large fires:</u> FRCC stand determination\$ Fuels map revision Vegetation map revision Photo documentation\$

New Innovations: Non-Permanent Circular Plot Methods and Results

Many of the most important fire effects objectives for the Teton Interagency Fire program involve determining the density of trees and shrubs. In particular, overstory and pole tree mortality, aspen suckering, shrub regeneration, and other measurements directly address whether or not prescribed burns are achieving desired results. Unfortunately, it has been difficult to collect enough density data from permanent FMH plots to make statistical inferences. Minimum plot calculations based on initial sampling suggest unrealistic plot numbers – in some cases in the hundreds.

In order to obtain density data with at least 80% confidence, a method of non-permanent density plots has been adapted from Kilpatrick, et al (2003). This method uses randomized transects with circular plots situated at randomized distances. Minimum plot calculations are made in the field to assure desired sample sizes are obtained. Two examples of successful application of this monitoring method are shown below.

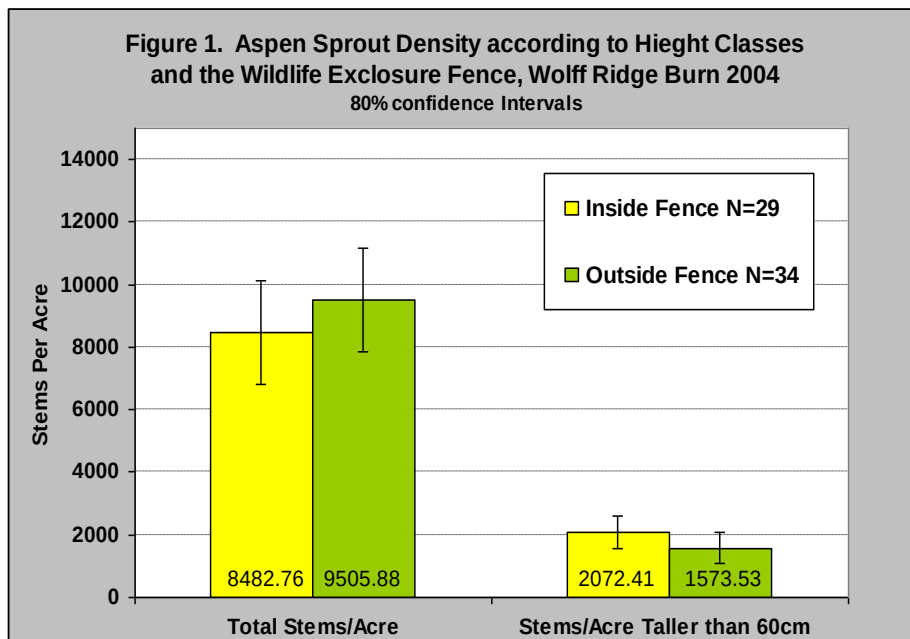
Monitoring Aspen inside the Wolff Ridge Elk Exclosure Fence:

The 2002 Wolff Ridge prescribed burn treated over 400 acres of aspen in Grand Teton National Park. In 2003, fire and resource managers became concerned that wild ungulates were browsing aspen regeneration to the degree that successful tree reproduction could be compromised. An experimental 60 acre electric exclosure fence was installed to determine if such fences could resolve the browsing dilemma. The fence project required weekly maintenance as elk, bison, and moose occasionally broke through.

In 2004, the fire effects crew used non-permanent 100th acre circular plots inside and outside of the fence to count live aspen sprouts by height classes and browse status. The height classes were: 0-15cm, 15-30cm, 30-60cm, 60cm-1m, 1-2m, 2-3m, etc. Two meters is considered by wildlife biologists to be tall enough to escape winter browsing by ungulates. Sprouts were considered browsed if the dominant leader had been removed since the previous growing season.

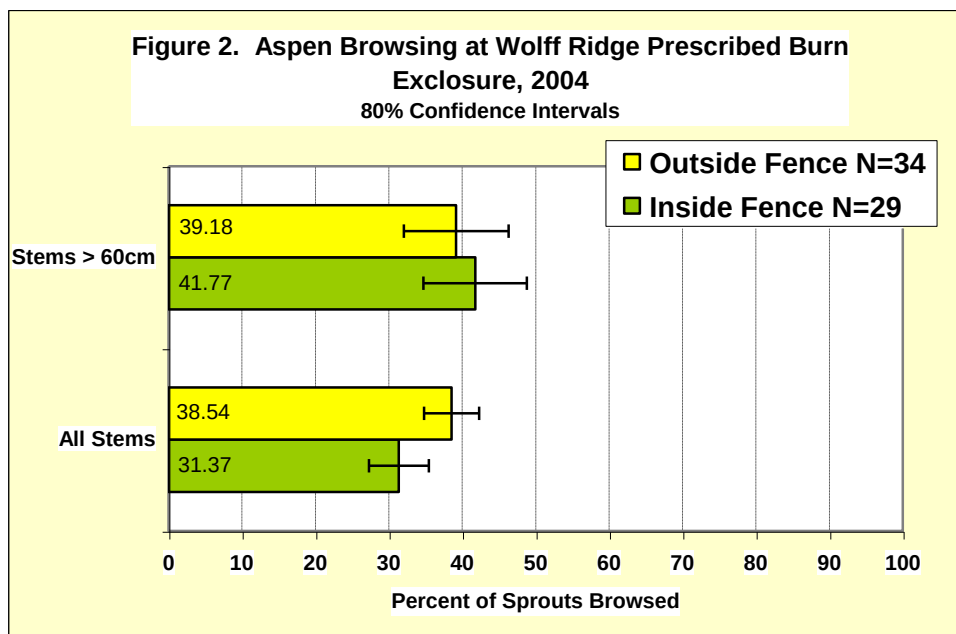
Minimum plot calculations for an 80% confidence/alpha level of .2 were conducted in the field to determine how many circular plots to conduct. Inside the fence 29 plots were needed, and outside in the designated control area 34 plots were needed.

Preliminary results indicate that aspen sprouting response has been good. Figure 1 shows that there is not a significant difference in density inside and



outside of the fence, which is to be expected at this time. Aspen heights were mainly in the 60cm-1m class or shorter.

Average browsing of stems inside the fence over last winter was 31%, and outside of the fence was 38%. The number of stems browsed to the 30-60cm height class suggests that the snow line was likely within that range also. Aspen sprouts taller than 60cm were separated for comparison in figure 2. The number of browsed stems that are tall may be greater inside the fence than outside but the data is not significant.



Measuring Bitterbrush Recovery at Blacktail Butte

In 1997 and 1998 two prescribed burns were conducted at Blacktail Butte in Grand Teton National park with the objective of introducing disturbance to old and dense bitterbrush (*Purshia tridentata*) and sagebrush (*Artemisia tridentata* var. *Vaseyana*) communities. The abundant bitterbrush in these project areas provides important winter and transitional habitat for moose, however the shrubs were very old and lacked age class diversity. Wildlife biologists requested that burn prescriptions target optimal bitterbrush resprouting (fast moving flaming front, moist soil, and effective sagebrush removal).

The formal fire effects monitoring program at GRTE was still in preliminary stages in 1997, however two brush plots were installed in the Blacktail Unit C burn. In 1998, the Gros Ventre South prescribed burn treated additional bitterbrush in an adjacent unit. The two FMH plots were re-read each summer for seven years post burn. The plots showed a precipitous decline in bitterbrush immediately post burn, but the data was not statistically useful, as figure 3 shows.

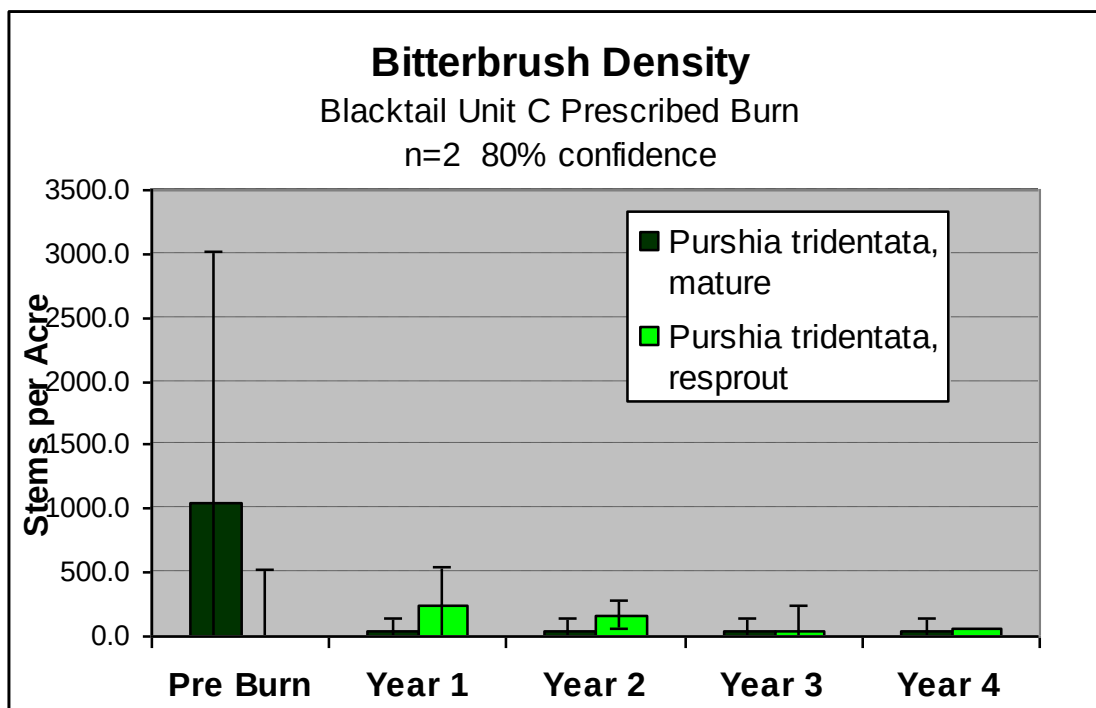


Figure 3. Bitterbrush response to the 1997 Blacktail Unit C burn according to FMH plots.

In 2004, the fire effects crew used non-permanent circular plots to evaluate the recovery of bitterbrush and sagebrush in the two prescribed burn units. They also collected density data from an unburned area across the road as a control study. A total of 51 plots in the three units were completed in two field days. The 80% confident results are shown on Figure 4.

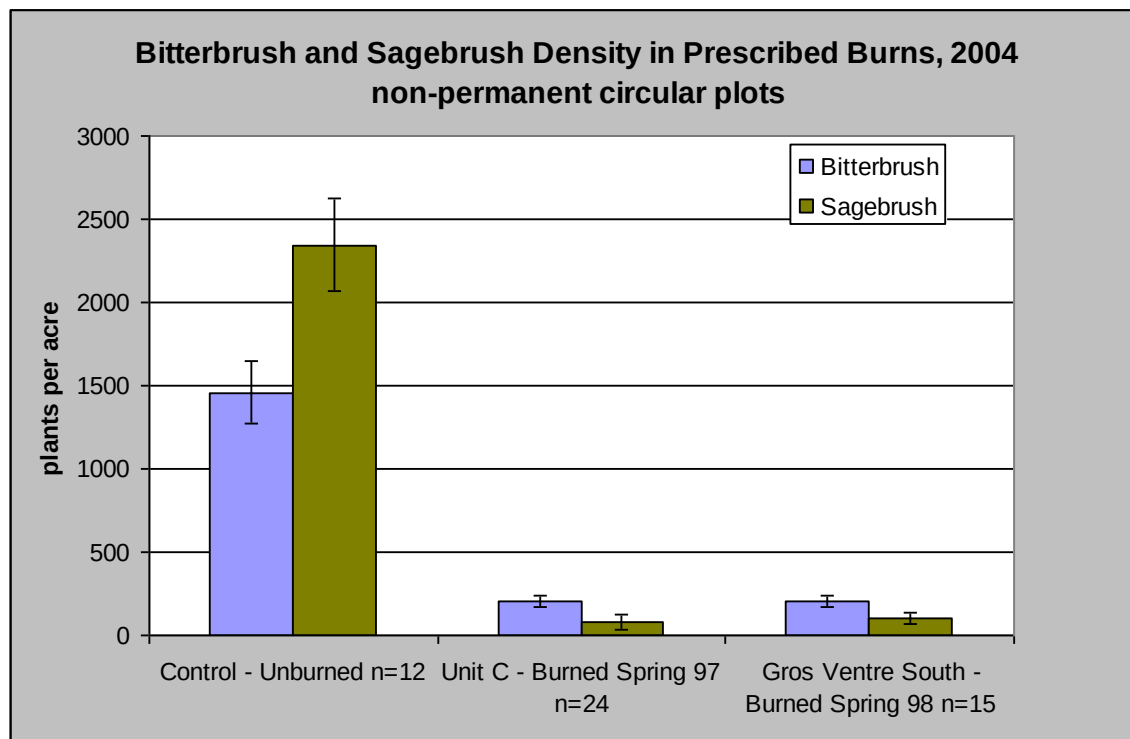


Figure 4. Bitterbrush and sagebrush density at Blacktail Butte 6 and 7 years post burn.

Monitoring Mechanical Thinning

The Grand Teton National Park fuels management program is developing standardized protocols for monitoring mechanical thinning projects in the park. This monitoring uses a combination of photopoints, Brown's transects, circular "common stand exam" plots, and sightability measurements that use visibility through the forest as an index of ladder fuels. Data is collected to obtain 80% confident results for each project. See attached draft monitoring unit description.

The Bridger-Teton National Forest is beginning a process of designing a monitoring system for mechanical thinning projects with help from the interagency fire effects program. The resulting protocols will be included in an amended version of the 2001 Bridger-Teton National Forest Fire Effects Monitoring Handbook.

References

Kilpatrick, S., D. Clause, and D. Scott . 2003. Aspen Response To Prescribed Fire, Mechanical Treatments, And Ungulate Herbivory. In Fire, fuel treatments, and ecological restoration: Conference proceedings; 2002 16-18 April; Fort Collins, CO. Omi, Philip N.; Joyce, Linda A., technical editors. Proceedings RMRS-P-29. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 475 p.

Grand Teton National Park Fuels Treatment Monitoring Unit Description

Monitoring Unit Code: FMXCOIT10

Monitoring Type Name: MIXED CONIFER – Fuels Treatment



Untreated mixed conifer



Mixed conifer 8 years post mechanical treatment

VEGETATION DESCRIPTION:

This monitoring type consists of wildland-urban interface mixed conifer forest with closed canopy. Lodgepole Pine, Douglas-fir, and subalpine fir are the dominant trees. Occasionally Englemann spruce and even Colorado blue spruce are included. Soils are often coarse and poorly developed (Mattson and Despain, 1985).

In **lodgepole-dominated stands**, understory vegetation is sparse and fuel loading can vary dramatically. According to Bradley et al (1992) average fuel loads are 15 to 18 tons per acre, although maximum loads were found to be much higher. Tree mortality from past fires and stand competition comprises most of the fuel. Fire return intervals range widely (22-300 years) because of fuel loading cycles. Usually, stand replacing fires spread from adjacent spruce, fir, or sagebrush (Steele et al, 1983).

This forest type is well described in Bradley, et al (1992) as LP-2 (Mature stands) and LP-3 (Overmature stands). The overstory is dominated by closed-canopy lodgepole pine (*Pinus contorta*), which may include up to 30% other conifers such as limber pine (*Pinus flexilis*), Douglas-fir (*Pseudotsuga menziesii*) subalpine fir (*Abies lasiocarpa*), and Englemann spruce (*Picea engelmannii*). In some cases aspen trees (*Populus tremuloides*) are present but declining. The mid-story generally contains pole and seedling size conifers. The shrub layer may include grouse whortleberry (*Vaccinium*

scoparium) dwarf huckleberry (*Vaccinium membranaceum*), snowberry (*Symphoricarpos oreophilus*), Oregon grape (*Berberis repens*), wild rose (*Rosa woodsii*), gooseberry (*Ribes spp.*), serviceberry (*Amelanchier alnifolia*), and buffaloberry (*Shepherdia canadensis*). Herbaceous ground cover includes pinegrass (*Calamagrostis rubescens*), elk sedge (*Carex geyeri*), heart-leaf arnica (*Arnica cordifolia*),

Douglas-fir / Subalpine Fir stands occur on upland sites on Northerly Aspects from Northeast to Northwest and slopes with elevations ranging from 6300' to 8500'. Slopes are slight to steep (5 to 50%). Soils range from gravely loam to fine sandy loam. Large boulders may be present across sites where deposited by glaciers.

The overstory is dominated by Douglas-fir, with co-dominant and subcanopy subalpine fir, limber pine, lodgepole pine, and Englemann spruce. Aspen may be present in the stand but not reproducing successfully. Dead and down fuel loading can be quite heavy, but understory vegetation is usually sparse. The shrub layer includes snowberry, spirea (*Spirea betulafolia*) mountain lover (*Paxistima myrsinites*), oregon grape, wild rose, gooseberry, and serviceberry. Herbaceous vegetation includes pinegrass, aster (*Aster spp.*), fireweed (*Epilobium angustifolium*), and heart-leaf arnica.

TREATMENT OBJECTIVES:

Objectives for fuels reduction projects describe measurable changes in vegetation that reference the primary goals of improving firefighter and public safety during wildland urban interface fire events.

- Initially reduce dead and down fuel loading to 10 tons per acre across the project area. Maintain fuel loading at 10-15 tons per acre using follow-up treatments.
- Initially remove all conifer seedlings. Maintain seedling density with follow-up treatments that remove 60-80% of seedlings.
- Remove pole trees leaving standing live clumps no bigger than 12 feet in diameter, with 12 foot corridors separating clumps. In subsequent maintenance treatments, reduce Pole size tree density by 10-30% across the project area.
- Reduce overstory trees spacing distance to 12 feet (1500 stems per acre), with an irregular, natural-looking distribution across the treatment area. In subsequent treatments, limit the reduction/mortality of 10+cm dbh overstory trees to <20%.
- Remove lower branches on pole and overstory trees up to 12 feet. Use follow-up treatments to maintain visibility through the understory so that vegetation obscuring a sight board averages 20% or less from 0-2.5 meters on a 50-foot transect over the project area.

TREATMENT METHODS:

Mechanical thinning and prescribed burning are utilized separately or in combination to accomplish treatment objectives. Appendix A provides treatment specifications for

mechanical methods. Appendix B provides prescription and fire behavior parameters for prescribed burning.

MONITORING PROTOCOLS:

PART I – PHOTOPPOINTS:

Establish permanent photo points marked with rebar and record GPS coordinates. Use a minimum of two photopoints, and two per additional 10 acres, up to a maximum of six. Use a photo board to display photopoint number, azimuth, project location, and date. Place the sightability board in the picture at 50 ft. Use both slide film and digital. Record this data as well as GPS coordinates on a photo record sheet. Choose sights that show a distinguishable feature that can be referenced in future photos if possible.

PART II –OVERSTORY, POLE AND SEEDLING TREE DATA: VARIABLE AND FIXED RADIUS “STAND EXAM” PLOTS:

- Start at a permanent photopoint location near the center of the treatment unit. Choose a random azimuth and pace distance and navigate to the first plot. Determine whether this plot represents the target vegetation and fuels characteristics. If not, continue along the azimuth for the designated pace distance and/or choose a new azimuth.
- Mark the center of the plot with a flag. For overstory trees, use a prism to select trees for a variable radius plot. Use a prism that gives approximately 10 trees, such as a 20 BAF. For each tree, record dbh, height, crown ratio, species, live/dead status, damage and severity.
- For pole and seedling trees use a fixed radius plot at the same center point. Select a plot size to obtain adequate samples. Increase the plot size with increased stand/clone heterogeneity. Each sampling event (pre, post, year5, etc.) must use the same plot size but the size can vary between events. Plot sizes can be different for seedlings and poles if necessary. Indicate plot sizes on the top of the data sheet.
- Seedling trees are shorter than 4.5 feet in height. Tally by species, live/dead status, and provide an average height to the nearest 1 foot.
- Pole trees are taller than 4.5 feet, and have a DBH from 0.1 – 4.9 inches. Tally by species, live/dead status, and dbh classes, as shown below:

Diameter	DBH class
0.1 – 1 inches	1
1.1 – 3 inches	2
3.1 – 4.9 inches	4

- Proceed along a random azimuth from this location and sample plots at the random pace intervals until the edge of the unit or community type is reached. At this time choose another random azimuth that continues within the sampling unit

and continue with the chosen pace interval until the desired number of plots are finished.

- Continue the above procedure until the required sample size and statistical reliability is achieved for overstory, pole, and seedling trees using the following formula (e.g. 80% reliability with 20% error).

$$N = (t)^2 * (s)^2 / (P * M)^2$$

N = required sample size

t = t table value for desired distribution (Choose your confidence interval and use preliminary sample size minus 1. A normal distribution will be 2-tailed)

s = standard deviation

P = percent error (e.g. 20% = 0.20)

M = mean # stems/plot

DOWNED WOODY FUELS: BROWN'S TRANSECTS

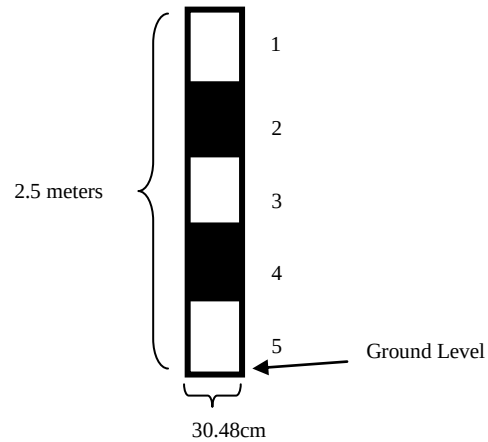
- Conduct two 50ft. Browns transects at random azimuths from each plot center. Use the first 6 ft. for 1 and 10 hour fuels, 12 ft. for 100 hour fuels, and record all 1000 hour fuels by diameter and decay class (sound or rotten).
- Record the transect slope.
- Measure Duff depth at 6', 12' and 50' to the nearest 10th inch.
- Estimate average fuel bed depth (from the bottom of the litter layer to the highest downed woody fuel particles)

SIGHTABILITY

Sightability classes are used to determine effectiveness of limbing and brushing in reducing ladder fuels.

- For each of the browns transects, set up the sight board at the end of the 50 foot tape.
- At plot center, look down the transect. Starting with the top rectangle (Number 1) of the sight board, record the obscurity class for each of the five sections until the ground is reached (Number 5).
- Obscurity Classes:
 - 1 = 0-20% OBSCURED
 - 2 = 21-40% OBSCURED
 - 3 = 41-60% OBSCURED
 - 4 = 61-80% OBSCURED
 - 5 = 80-100% OBSCURED

- Roll-up sight board:



EQUIPMENT:

30 meter tape measure, data sheets, project unit map, compass, go-no-go, ruler, trowel, scientific calculator, Student's t-test table, roll-up visual obscenity sight board, map of sampling unit, digital camera, slide camera, film, dry erase marker, photo board, photo record sheets, rebar, hammer, GPS unit, 20 BAF prism, loggers tape, clinometer

APPENDIX A: MECHANICAL TREATMENT SPECIFICATIONS:

Ground Fuels:

- Sound wood may be piled in log decks, Rotten logs placed in slash piles.
- Remaining ground fuels left should be limbed, with no stobbs > than 1 inch high.

Thinning:

- Thin stems (boles or trunks) or groups of stems to a spacing distance of 12 feet between trees. Try to maintain an irregular distribution across the treatment area to maintain a more natural look.
- Leave no stumps higher than 2 inches on the uphill side.
- Preferentially remove snags and sub-alpine fir (*abies lasiocarpa*).
- Clumps of even-aged regrowth should be no bigger than 12 feet in diameter with 12 foot corridors separating clumps. Remove seedlings within regrowth clumps (remove all 1 inch and under).
- Use proper thinning techniques, flush cut all stumps to no more than 2 inch high with no angle cuts left (no pongee sticks).
- Leave wildlife snags within the treatment area, but fall other standing dead trees that will help achieve the 12 feet thinning standard.

Pruning:

- On mature trees (DBH > 6"), prune with a pole saw all limbs that reach to within 12 feet of the ground.
- On smaller trees (DBH < 6"), prune with a pole saw or loppers to 12 feet or ½ the tree height.
- Use proper pruning techniques, leave no stobs > than ½ inch from the bole of the tree, and minimize scarring to the bole of the tree. Prune branches just outside of the bud swell.

Pile Construction:

- Choose pile location with 20-30 foot flame lengths in mind.
- Locate piles in natural openings or within thinning corridors.
- Construct piles for burning. Use fine flashy fuels such as small trees and limbs for the base of the pile and add on vertically.
- Do not allow piles to grow horizontally because these piles will require much more tending work while burning.

APPENDIX B: BURNING PRESCRIPTION

Prescription

* indicates mandatory item (See Appendix G for complete Behave Outputs)

Time of Year	HOT	COOL	Optimum
* Dry Bulb Temperature	75	50	72
Relative Humidity	15%	35%	25%
* Wind Speed (Eye Level)	6	0	4
Wind Direction	SW	SE	SW
* Fuel Moisture-1 Hour	6	12	8
Fuel Moisture-10 Hour	7	13	9
Fuel Moisture-100 Hour	7	15	11
Fuel Moisture - Live Woody	50	150	65
Fuel Moisture-Live Herb	25	125	50
Slope	20%	0%	0%

FIRE BEHAVIOR

NFFL Fuel Model 2

	HOT	COOL	Optimum
Rate of Spread - Chains/hour	62.8	1.5	26.6
Flame Length - Feet	8.4	1.3	5.5
Effective Wind Speed - MPH			
Spotting Distance - Miles	0.4	0.0	0.3
Probability of Ignition	53%	19%	36%

FIRE BEHAVIOR

NFFL Fuel Model 8

	HOT	COOL	Optimum
Rate of Spread - Chains/Hour	2.6	0.2	1.3
Flame Length - Feet	1.2	0.3	0.9
Spotting Distance - Miles	0.4	0	0.3
Probability of Ignition	53%	19%	36%
Scorch Height - Feet	1	0	0
Mortality	80%	80%	80%

FIRE BEHAVIOR

NFFL Fuel Model 10

	HOT	COOL	Optimum
Rate of Spread - Chains/Hour	16.1	0.6	7.7
Flame Length - Feet	7.1	1.5	4.9
Spotting Distance - Miles	0.4	0.0	0.3
Probability of Ignition	53%	19%	36%
Scorch Height - Feet	43	04	19
Mortality	98%	80%	80%

Project location_____Monitoring Event_____Date_____

Recorders_____Random Pace_____Random Azimuths_____,_____,_____

Prism BAF_____ Circle Plot size: Seedlings: 10th 100th 500th 1000th acre Radius: 37.2' 11.7' 5.26' 3.7'
Poles: 10th 100th 500th 1000th acre Radius: 37.2' 11.7' 5.26' 3.7'

Plot #	Overstory Trees (> 5"DBH) – Variable radius plot								Pole Trees > 4.5' DBH .1-4.9" – Fixed radius plot				Seedling Trees .1 – 4.5' height – fixed radius plot			
	Tree #	Species	L / D	DBH	Height	CR	Damage	Sev.	Species	L / D	Class	Tally	Species	L / D	Avg. Ht.	Tally
	Browns 1				Sightability 1				Browns 2				Sightability 2			
	<u>1hour</u>	<u>10 hour</u>	<u>100 hour</u>		1	<u>Obscurity</u>			<u>1hour</u>	<u>10 hour</u>	<u>100 hour</u>		1	<u>Obscurity</u>		
					2								2			
					3								3			
	<u>1000 hr S</u> <u>1000 hr R</u>				4				<u>1000 hr S</u> <u>1000 hr R</u>				4			
					5								5			

Fuels Treatment Photopoint Data Sheet

Project location _____ Monitoring Event

Date _____

Recorders _____ Digital Camera _____ Film _____

Camera_____ Roll_____

GPS datum_____ Marking Monument Type_____

[illegible]