National Park Service

Mount Rushmore National Memorial

South Dakota

Fire Effects Monitoring Plan

INTRODUCTION

Prescribed fire will be used to maintain and restore the fire adapted ecosystems at Mount Rushmore. National Park Service (NPS) Reference Manual 18 states, "Monitoring is a critical component of fire management and the Fire Monitoring Plan is important to identify why monitoring will be done, what will be monitored, how it will be monitored, where it will be done, and how often it will be completed." Monitoring of these fires is mandated in Director's Order #18: Wildland Fire Management issued in 1998. Section 5.2, *Fire Management Plans* (no. 10) states, "Include procedure for short and long term monitoring to document that overall program objectives are being met and undesired effects are not occurring". Section 5.8 directly addresses *Prescribed Fire Monitoring*:

a) Fire effects monitoring must be done to evaluate the degree to which objectives are accomplished.
b) Long-term monitoring is required to document that overall programmatic objectives are being met and undesired effects are not occurring.
c) Evaluation of fire effects data is the joint responsibility of fire management and natural resource management personnel.

MONITORING DESIGN

SAMPLING DESIGN

Two plots established at Mount Rushmore follow standard Fire Monitoring Handbook (FMH) (2003) protocols. The sampling design for the FMH plots are contained in the individual monitoring unit description sheet found in Appendix 1. Forest & Fuels Plots have been established in two management units undergoing fuels treatments. Protocols and datasheets are attached in Appendix 2. Long-term photo monitoring points have also been established (see Appendix 3).

FIELD MEASUREMENT

The individual variables to be measured are defined in the monitoring unit descriptions found in Appendix 1. All plots are marked with steel rebar approximately half a meter in height. Each piece of rebar has a brass tag indicating its location within the plot. The rebar at the zero end of each plot has a tag with complete plot data as specified by the handbook. All locations have been georeferenced with a GPS unit. A hard copy of each plot location is retained in the Northern Great Plains Fire Management Office (NGP) at Wind Cave National Park. A digital text file with UTM coordinates and ArcView 'shape' file are also on file at the NGP. The Northern Great Plains Fire Monitoring Crew will retain copies and backups and will be responsible for providing updated versions to Mount Rushmore as needed.

MONITORING LOCATION

Currently there are 2 FMH monitoring plots, 27 Forest & Fuels Plots, and 5 photo points at Mount Rushmore (Fig. 1).

PRESCRIBED FIRE MONITORING PARAMETERS

Mount Rushmore has adopted the NPS FMH (2003) as a guide for fire effects monitoring. The handbook identifies four monitoring levels:

Level 1 – Reconnaissance	Fire Cause, location, size, fuel and vegetation types, relative fire activity, potential for spread, current and forecasted weather, resource or safety threats and constraints, and smoke volume and movement
Level 2 – Fire Conditions	Fire monitoring period, ambient conditions – topographic and fire weather, fuel model, fire characteristic, and smoke characteristic
Level 3 – Immediate Post fire Effects	Fuel reduction, vegetative change or other objective dependent variables with in 1 to 5 years after a prescribed fire
Level 4 – Long-term Change	Continued monitoring of Level 3 variables to measure trends and change over time

The FMH plots that have been described in this document thus far are being used to examine levels 3 and 4.

Wildland fires that are suppressed will be monitored at levels 1 and 2 with observations entered into the park's monitoring database. In the event that long-term fire effects plots are burned in a wildland fire, they will be read by the NGP Fire Monitoring Crew, according to the schedule of plot rereads following a prescribed fire treatment. Level 1 and 2 monitoring observations will be filed with the final fire package and a copy placed with the records for the Fire Management Unit that was burned.

Prescribed fires will meet at least the Level 1 and 2 recommended standards. If there are FMH plots in a unit, information on Level 3 and 4 Variables will be collected.

Level 1 variables

Reconnaissance monitoring provides a basic overview of the fire event. The following variables will be collected on all fires.
- Fire cause (origin), location and size
- Fuels and vegetation type
- Relative fire activity
- Potential for further spread
- Current and forecasted weather
- Resource or safety threats and constraints
- Smoke volume and movement

Specific information on the collection of these variables can be found in the NPS Fire Monitoring Handbook (2003) or the RX-91 – 'Monitoring Prescribed and Wildland Fire' text.

Level 2 variables

Fire conditions monitoring provides information on fire weather, fire behavior and resource values at risk. The following variables will be collected and summarized in a monitoring report on all prescribed fires.

- Fire monitoring period
    - fire number and name
    - observations data and time
    - monitor's name
- Ambient conditions
    - topographic variables
    - slope (%)
    - aspect
- Fire weather variables
    - dry bulb temperature
    - relative humidity
    - wind speed
    - wind direction
    - fuel shading and/or cloud cover
    - time-lag fuel moisture
    - live fuel moisture
- Soil moisture
- Fuel model
- Fire characteristics
    - linear rate of spread
    - perimeter or area growth
    - flame length
    - fire spread directions
- Smoke characteristics (based on state and local requirements)

INTENDED DATA ANALYSIS

Plot installations will be based on prescribed fire priorities and with the intention of achieving a statistically valid sample size within five years for priority monitoring units. The Northern Great Plains Fire Ecologist will be responsible for checking the minimum plot numbers in all units that have more than five plots installed. Each monitoring unit description delineates the variables that will be analyzed. When minimum plot numbers have been reached, objectives will be evaluated after the data have been checked to meet the assumptions of the statistical test. If the data meet the assumptions, including normality, then confidence intervals will be used for change over time comparisons. If data do not meet the assumptions, a statistician will be consulted. Correlation of Level 2 data with vegetation data can be done with either regression or multivariate analysis.

The Northern Great Plains Fire Ecologist will compare data with fire effects research that has been completed in the park and area. Inconsistencies should lead the ecologist to examine different methodologies, data interpretation, and potential research questions.

MONITORING IMPLEMENTATION SCHEDULE

Timing of monitoring

All plots are currently monitored at peak diversity for the native vegetation approximately halfway between the peak in cool and warm season grasses. All plots are currently being read pre-burn, immediately post-burn, and 1, 2, 5, 10, and 20 years post-burn.

Pre-burn Sampling

Plots should be installed the growing season before prescribed fires. All plots that have not burned within 2 years of installation will not be reread until that unit is again scheduled to burn. These plots can also be considered for control plots depending on long-term prescribed fire planning.

Post-burn sampling

Post-burn sampling will be done immediately post-burn and 1, 2, 5, 10, and 20 years after the prescribed fire. Plots that burn in the spring will be read at peak phenology that summer, and then at the regular schedule (1, 2, 5, 10, and 20 year). The 1-year reads for forest plots burned in the spring are during the growing season one year after the prescribed fire. Fall prescribed fires will be read the following summer as 1 year post-burn reads. If a unit is scheduled to be burned for a second or third time between reads, an additional pre-burn read will be added. For example, a unit burned in the spring of 2000 would be sampled within a week following the fire, 1 year read summer 2000, 2 year read summer 2001, and 5 year read summer 2004. The unit is then scheduled to burn again in 2008. A second pre-burn read should be added summer 2007.

DATA MANAGEMENT

Other monitoring programs have shown that between 25-40% of the time associated with monitoring should be on data management. The data for Mount Rushmore is collected and managed by the Northern Great Plains Fire Monitoring Crew located at Wind Cave National Park, Hot Springs, South Dakota. All data collected at Mount Rushmore will be entered and checked by this crew at their office. Generally the seasonal field staff enters and checks data. This process is supervised the NGP Lead Monitor and Fire Ecologist. Original copies of all data will be kept at the crew's office. Hard copies of the Plot Location Data Sheets will be archived at the NGP Fire Management Office. The Lead Monitor will provide monitoring data to the Mount Rushmore Resource Management staff when requested. Data are currently entered and analyzed in the FEAT software. It is backed up to the server at Wind Cave. It will be sent annually to the Midwest Regional Ecologist in conjunction with the annual report. Global positioning data of plot locations are stored on CD at the Fire Monitoring Office at Wind Cave.

QUALITY CONTROL

Data quality will be ensured through proper training of the crew in data collection and a system of checks in the data entry process. All data sheets will be checked by the lead crewmember before leaving a plot for data accuracy and completeness. Data will be summarized annually and results reported to the park and regional fire ecologist. A program review should happen every 3-5 years to maintain consistency of data collection and analysis and re-assessment of program

requirements. More frequent review may be necessary if there are significant staffing changes, additional ecological concerns, or by request of the park or monitoring crew.

SOURCES OF DATA ERRORS

Errors in recording can be reduced by checking all data sheets for completeness and accuracy before leaving the plot. Standardized crew training at the beginning of the season will insure all data are being collected in the same manner by all crewmembers. Transcription errors will be corrected by checking all data once entered in the computer. Collecting voucher specimens and using the study collection to verify plant identifications can minimize incorrect identification of plant species. All unknown plant species will be photographed and added to the unknown plant database. These photos can be used as a field reference to insure that all unknowns are consistently observed. Mount Rushmore Resource Management personnel will be notified of unknowns of particular concern so special attention can be given to identify it. Undersampling of less-frequently occurring species is a large problem in the grass types.

The impacts of monitoring include compacting of fuels and vegetation and the collection of voucher plant specimens. Compaction can be minimized by crew awareness as to where data are collected. Voucher specimens are not collected in the plot – if no other specimen is found, the unknown plant will be photographed and added to the unknown plant photo database. Accurate plot locations including GPS data will aid in plot location and minimize vegetative compaction. Test all directions by having new crewmembers use previously written directions to ensure accuracy. Incomplete or missing data will be corrected as soon as possible. Plot protocols need to be reviewed annually with the seasonal crew prior to beginning work to insure that data are accurately collected. Problems encountered by the field crew must be brought to the attention of the lead monitor and fire ecologist.

RESPONSIBLE PARTIES

Administrative duties will be assigned as follows:
- *Northern Great Plains Fire Ecologist*: Plan revision, crew supervision, data management and data analysis
- *Superintendent, Mount Rushmore National Memorial*: Park liaison
- *Northern Great Plains Lead Monitor*: Data collection, data entry, data management and field crew supervision
- *Midwest Regional Fire Ecologist*: Coordinate program reviews

MANAGEMENT IMPLICATIONS OF MONITORING RESULTS

Monitoring results will be summarized and presented to the park in the fall meeting of the Fire Coordinator with the NGP Fire management Officer, Prescribed Fire Specialist and Fire Ecologist. This meeting helps coordinate fire activities including prescribed fire for the park in the coming year. The annual report information can be conveyed to Mount Rushmore Resource Management in an additional meeting as requested.

Review of the data summary and analysis by the NGP Fire Ecologist, Prescribed Fire Specialist, and Mount Rushmore Resource Management staff should determine if the current program is

moving the vegetation towards the desired conditions and/or having unwanted results. Targets should be reviewed and refined, and prescribed fire prescriptions and other vegetation management techniques could be adjusted to compensate. This review could also generate questions that may lead to fire effects research being conducted in the park. Information from the Mount Rushmore program could be analyzed with other parks from the NGP group as appropriate and should be presented to other parks and at scientific meetings and publications.

CONSULTATION AND COORDINATION

The Northern Great Plains Fire Monitoring Crew is responsible for coordination and consultation with other parks in the group, fire management personnel, and the Midwest Regional Fire Ecologist. Mount Rushmore Resource Management staff will be responsible for coordination and consultation with the park and all other cooperators.
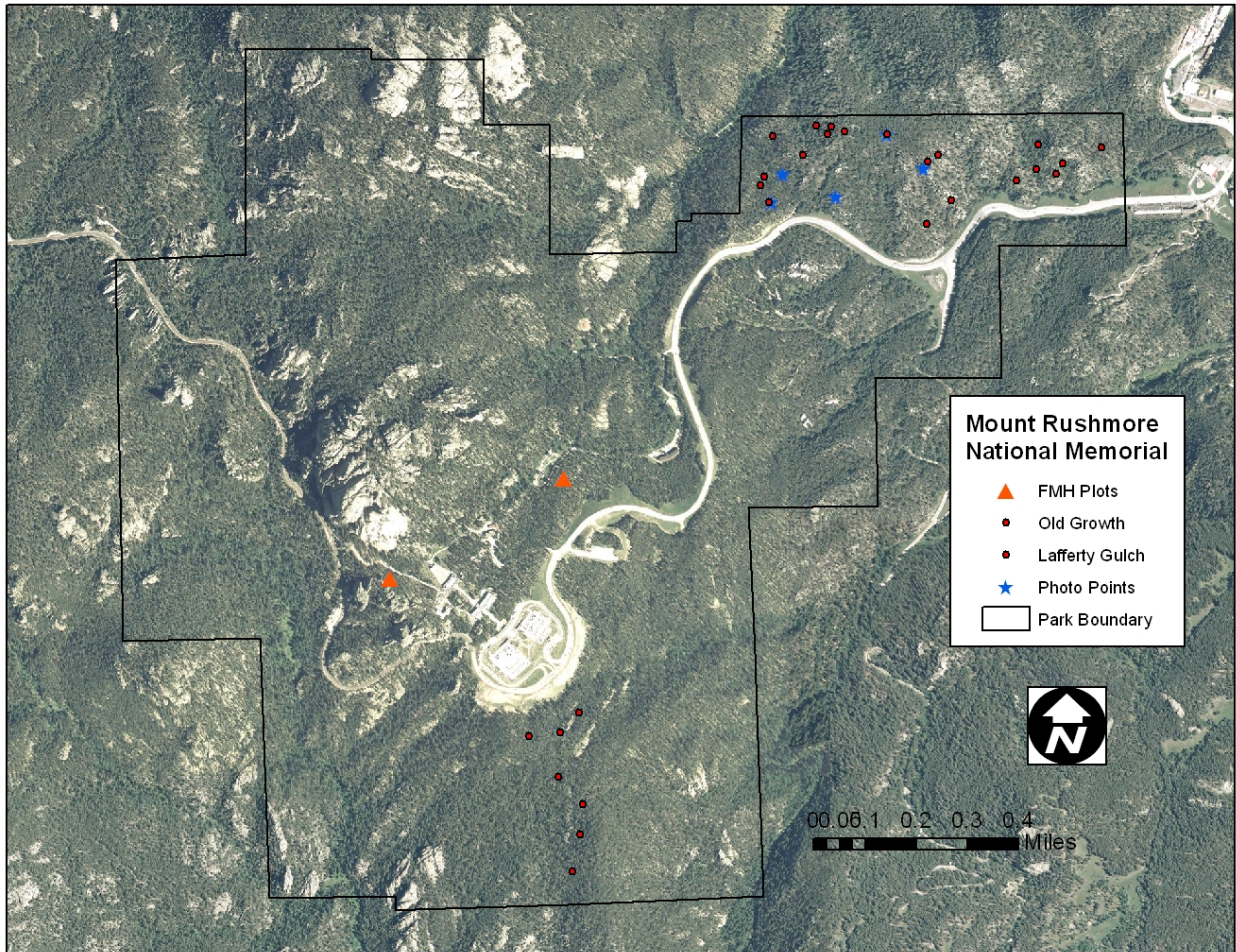
LITERATURE CITED

USDI National Park Service. 1998. Directors order #18: wildland fire management.

USDI National Park Service. 1999. Reference manual 18.

USDI National Park Service. 2003. Fire monitoring handbook. National Interagency Fire Center, Boise, ID. 274 pp.

FIGURES

FIGURE 1. LOCATION OF FIRE EFFECTS MONITORING PLOTS.

APPENDICES

APPENDIX 1 – MONITORING UNIT DESCRIPTION SHEETS

Monitoring Type Code: FPIPO1D09   **Date Described:** 6 /09/97

Monitoring Type Name: Ponderosa Pine Forest/Mixed Pine Community

Prepared by: A. Powers, G. Bradshaw, B. Braudis, G. Kemp, P. Reeberg, M. Pflaum,
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Updated by: C. Wienk, A. Thorstenson – 11/02

Physical Description
Elevation ranges from 4,000 to 6,200 feet above sea level. Soil types include: Pactola and Virkula soils intermingled with areas of rock outcrops and large boulders on the surface, in some areas. The Virkula soils are well drained and found in areas with slopes ranging from 2 to 35 percent. Pactola soils are deep, well drained and found in areas with slopes from 6 to 60 percent.

Biological Description
Overstory dominated by ponderosa pine (*Pinus ponderosa*). Other trees include ironwood (*Ostrya virginiana*), bur oak (*Quercus macrocarpa*), paper birch (*Betula papyrifera*), and quaking aspen (*Populus tremuloides*). The most common shrub species is common juniper (*Juniperus communis*), followed by snowberry (*Symphoricarpos occidentalis*), currant (*Ribes* spp.), and chokecherry (*Prunus virginiana*). The understory consists of Kentucky bluegrass (*Poa pratensis*), sedges (*Carex* spp.), Junegrass (*Koeleria macrantha*), rough-leaved ricegrass (*Oryzopsis asperifolia*), bluejoint reedgrass (*Calamagrostis canadensis*), poison ivy (*Toxicodendron radicans*), bearberry (*Arctostaphylos uva-ursi*), harebell (*Campanula rotundifolia*), timothy (*Phleum pratense*), and pinedrops (*Pterospora andromedea*).

Rejection Criteria
Large outcroppings or barren areas >20% of the plot; areas with anomalous vegetation; monitoring type boundaries; riparian areas or areas dominated by deciduous trees (> 30% cover); areas within 30 meters of roads, man-made trails, or human created clearings are to be rejected.

Desired Future Conditions
- Decrease non-native species.
- Maintain open-canopy ponderosa pine stands with overstory tree density in a range of 250-370 stems/ha (100-150 stems/acre).
- Increase 'patchiness' of ponderosa pine stands and increase the size of meadows.
- Promote or maintain age class diversity.
- Decrease density of pole-sized trees.
- Reduce fuel loads.

Burn Prescription
Units will be burned between April until green-up or Labor Day to late-October.

Fire Prescription Elements	
RH – 25-55 %	Average Rate of Spread – 0-3 chs/hour
Bulb – 30-85°	Average Flame Length - 0.4-1.5 feet
Average Mid-flame winds – 0-20 mph	1-hour TLFM – 6-14 %
Fuel loading – 3-5 tons per acre	10 hour TLFM – 8-15 %
Live Fuel Moisture – n/a	100-hour TLFM – 10-30 %

Monitoring Variables (in order of importance)
- Overstory density
- Total fuel loading
- Relative cover of native grass and forbs species

Prescribed Fire Objectives
Immediate Post-burn
- Reduce total fuel loading by 60 to 80%
- Reduce overstory density by 25%

2 Years Post-burn
- Increase herbaceous and shrub cover by at least 25%

Fire Monitoring Objectives
- Measure the average total fuel load in the ponderosa pine forest with a sufficient sample size to be 80% confident that the sample mean will be within 25% of the population mean.
- Measure the average density of all overstory trees, and the average density of all brush species with a sufficient sample size to be 80% confident that the sample mean will be within 25% of the population mean.
- Measure the average frequency for understory species with a sufficient sample size to be 80% confident that the sample mean will be within 25% of the population mean.

Plot Protocols

GENERAL PROTOCOLS

Preburn		YES	NO		YES	NO
	Control Plots/Opt		●	Herb Height/Rec	●	
	Herbaceous Density/Opt		●	Belt Transect Width: 5 meters		
	OP/Origin Buried		●	Abbreviated Tags	●	
	Voucher Specimens/Rec	●		Stakes Installed: All		
	Stereo Photography/Opt		●	Crown Intercept/Opt		●
	Brush Individuals/Rec		●	Herb. Fuel Load/Opt		●
	Herbaceous Data Collected at: Q4-Q1					

Burn		YES	NO		YES	NO
	Duff Moisture/Rec		●	Flame Zone Depth/Rec	●	

Postburn		YES	NO		YES	NO
	Herbaceous Data/Opt:			Herb. Fuel Load/Opt		●
	100 Pt. Burn Severity/Opt		●			

FOREST PLOT PROTOCOLS

Overstory		YES	NO		YES	NO
	Area sampled: 50 x20m			Quarters Sampled: Q1-Q4		
	Tree Damage/Rec	●		Crown Position/Rec	●	
	Dead Tree Damage/Opt		●	Dead Crown Position/Opt		●

Pole-size		YES	NO		YES	NO
	Area Sampled: 25 x10m			Quarters Sampled: Q1		
	Height/Rec	●		Poles Tagged/Rec		●

Seedling		YES	NO		YES	NO
	Area Sampled: 5 x 10m			Quarters Sampled: Subset of Q1		
	Height/Rec	●		Seedlings Mapped/Opt		●

Fuel Load		YES	NO		YES	NO
	Sampling Plane Length: 6, 6, 12, 100, 100			Fuel Continuity/Opt		●
	Aerial Fuel Load/Opt		●			

Postburn		YES	NO		YES	NO
	Char Height/Rec	●		Mortality/Rec	●	

Rec = Recommended   Opt = Optional

Protocols for Forest and Fuels Monitoring Plots

Plot Establishment
Circular plots with 10 m radius will be randomly located within the unit. If it is necessary to return to these plots, mark the center with a piece of rebar and use a brass tag for identification. (RX Fire, Plot ID#, Date). Mark N,S,E,W points with a washer and nail.

UTM coordinates and datum used will be recorded.

Photos may be taken (digital camera). At least two photos should be taken at each plot. Take each photo from one of the cardinal directions looking into the plot. An overview photo may also be taken. Select locations that provide a good overview of the plot and make sure to denote on the Plot Location Data Sheet the location of each photo. For repeatability, take the photo from the nail at each of these points, and place the photo board 2-3 meters into the plot. Take photo from standing or one knee crouch to best capture the character of the plot; indicate which is used in the notes. When revisiting plots, refer to previous photographs to ensure a good repeat photograph.

Equipment:
____ GPS unit
____ map of random points
____ UTM coordinates
____ 3 30-m tapes
____ 1 50-m tape
____ 8 chaining pins
____ DBH tape
____ ruler
____ go/no-go gage
____ compass
____ clinometer
____ data sheets
____ clipboard
____ pencils
____ digital camera
____ photo board
____ dry erase marker
____ 1 rebar
____ 6 nails/6 washers
____ brass tag

optional aids:
____ counter
____ 3 cords for dividing quarters

110 ft Brown's line. Data collection starts at 10 ft.

10 m
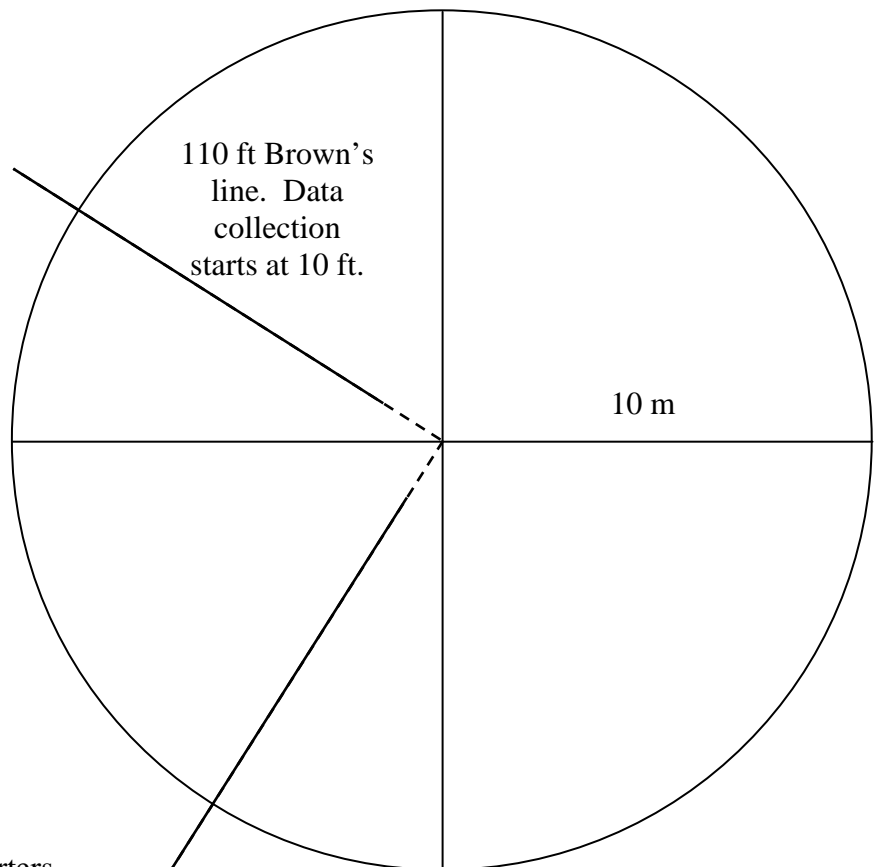
Monitoring:
Within the circular plot, DBH will be measured and recorded for all <u>live</u> ponderosa pine trees with a DBH greater than or equal to 2.5 cm. (A 10 meter cord from the center can be helpful in verifying if a tree is in or out. A tree is counted if the cord – do not stretch - touches the tree.) This data will be used to calculate average basal area and tree density of the unit. Basic stand structure information, such as number of trees per size class, will also be summarized from this data.

Seedlings may also be counted - by quarters, in all quarters. Indicate how many are live or dead. When seedlings are numerous, the use of several 10 meter cords to divide the quarter and indicate the circles edge is useful.

Two random azimuths will be selected for each plot to measure downed woody fuels using Brown's lines. A fifty meter tape will be used and run away from plot center at the random azimuth. A washer and nail will be placed at the terminus. Brown's line data will be read for 100 feet starting at 10 feet (10 ft to 110 ft. – this will avoid sampling in the trampled area around the center.). Brown's line protocols follow those outlined in the Fire Monitoring Handbook. Slope and azimuth should be recorded for each Brown's line, in addition to downed woody fuel, litter and duff.

Rejection criteria:
Generally, it is desired, that an acceptable plot will have a minimum of 10 trees in the size class of interest. Other areas that would justify rejection of random points include drainages dominated by deciduous trees and shrubs, man-made features such as roads, and areas that have recently been thinned or other human-caused disturbance.
If a random point falls adjacent to a rock outcrop the point will be moved ten meters in a direction perpendicular to the face of the rock outcrop. If the location is still not suitable, the point will be rejected.

Plot Location Data Sheet
Forest & Fuels

Plot ID: _____   Install Date: _____

Burn Unit: _____   Located By: _____

UTM Easting: _____   Hill Slope: _____

UTM Northing: _____   Aspect: _____

Zone: _____ Datum: _____

Comments for accessing plot (i.e. parking location, trail, reference landmark, etc.):

Locations of plot photos:

History of plot visits:

Date	Burn Status/Visit	Comments

Forest & Fuels Data Sheet

Plot ID: _____ Park: _____ Date: _____

Plot Status: _____ Unit: _____ Recorders: _____

Pole and Overstory Trees

NE Quarter (1)			SE Quarter (2)			SW Quarter (3)			NW Quarter (4)		
DBH			DBH			DBH			DBH		
1		21	1		21	1		21	1		21
2		22	2		22	2		22	2		22
3		23	3		23	3		23	3		23
4		24	4		24	4		24	4		24
5		25	5		25	5		25	5		25
6		26	6		26	6		26	6		26
7		27	7		27	7		27	7		27
8		28	8		28	8		28	8		28
9		29	9		29	9		29	9		29
10		30	10		30	10		30	10		30
11		31	11		31	11		31	11		31
12		32	12		32	12		32	12		32
13		33	13		33	13		33	13		33
14		34	14		34	14		34	14		34
15		35	15		35	15		35	15		35
16		36	16		36	16		36	16		36
17		37	17		37	17		37	17		37
18		38	18		38	18		38	18		38
19		39	19		39	19		39	19		39
20		40	20		40	20		40	20		40

Live Ponderosa Pine Seedlings

Quarter 1:	TOTAL	Quarter 2:	TOTAL
Quarter 3:	TOTAL	Quarter 4:	TOTAL

<u>Comments</u>

Date entered: _____ Entered by: _____

Forest & Fuels Data Sheet

Plot ID: _____   Park: _____   Date: _____

Plot Status: _____   Unit: _____   Recorders: _____

Transect 1   Compass Direction: _____   Slope: _____

# of Intercepts			Diameter (in.)		Litter and Duff Depths (in.)				
0-0.25" (1hr) 6'	0.25-1" (10hr) 6'	1-3" (100hr)12'	3"+ s (1000-hr)	3"+ r	L	D		L	D
				10			35		
				15			40		
				20			45		
				25			50		
				30			55		

Transect 2   Compass Direction: _____   Slope: _____

# of Intercepts			Diameter (in.)		Litter and Duff Depths (in.)				
0-0.25" (1hr) 6'	0.25-1" (10hr) 6'	1-3" (100hr)12'	3"+ s (1000-hr)	3"+ r	L	D		L	D
				10			35		
				15			40		
				20			45		
				25			50		
				30			55		

Comments

LONG TERM PHOTO MONITORING SHEET

Plot # _____   **Park:** _____   **Date:** _____

Burn Unit: _____   **Recorders:** _____

UTM Zone:_____ **UTMN:**_____ **UTME:**_____ **Datum:**_____ **EPE:**_____	**Camera height:** _____ft. **Lens size:** _____mm **Distance from pole:** _____ft. **Azimuth from camera to pole:** _____ **Height on pole used for shot:** _____ft	**Elevation:** _____ft **Slope along transect:** _____% **Slope of terrain:** _____% **No. of Photos Taken:** _____ **Compass Bearing**(s):

Describe the route to the plot, include or attach a hand drawn map illustrating these directions, including the plot layout, and significant features:

Visit	Initial/ Date	Comments
Install/Pre		
Immediate Post		
1 Year Post		
2 Year Post		
5 Year Post		
10 Year Post		

APPENDIX 4 – PLOT HISTORY

Burn Unit	Monitoring Type	Plot #	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Ponderosa Pine	PIPO_02-01	V		V								
Reardon's Rock	Ponderosa Pine	PIPO_09-01	V							thin	V	V	
Lafferty Gulch	Photo Points	5 locations						V	V			V/B	V
Lafferty Gulch	Ponderosa Pine	20 plots						V	V			V/B	V
Old Growth	Ponderosa Pine	7 plots											V

V = Visit; B = Burn