F. Wildland and Rx Fire Monitoring Plan

Knife River Indian Villages National Historic Site

Fire Effects Monitoring Plan

INTRODUCTION

Prescribed fire will be used to maintain and restore the fire adapted ecosystems at Knife River. 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

Plots established at Knife River follow standard Fire Monitoring Handbook (FMH) (2003) protocols as well as a number of plots using an alternative sampling protocol, described in Appendix ?. The sampling design for the FMH plots are contained in the individual monitoring unit description sheets found in Appendix 1. Long-term photo monitoring points have also been established.

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 Knife River as needed.

MONITORING LOCATION

Currently there are 20 monitoring plots and one photo point at Knife River (Fig. 1).

PRESCRIBED FIRE MONITORING PARAMETERS

Knife River 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 the 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. This will need to be examined after pilot sampling. All plots are currently being read pre-burn, immediately post-burn, and 1, 2, 5, 10, and 20 years post-burn.

Pre-burn Sampling

Pre-burn sampling will be done during peak phenology. 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 grassland plots burned in the spring are during the growing season the same year as the prescribed fire, and the 2-year read occurs in the following 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 Knife River 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 Knife River 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 Knife River in the Resource Management files. The Lead Monitor will provide monitoring data to the Knife River Resource Management staff annually on CD for archiving. Data are currently entered and analyzed in the FMH software. It is backed up to the server at Wind Cave. It will be sent annually to Knife River and 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. Knife River 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. An additional sampling technique, nested frequency, will be added after consulting with the regional fire ecologist to better sample the species richness found in these 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, Knife River National Monument*: 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 Committee 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 Knife River Resource Management in an additional meeting as requested.

Review of the data summary and analysis by the NGP Fire Ecologist, Prescribed Fire Specialist, and Knife River 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 Knife River 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. Knife River Resource Management staff will be responsible for coordination and consultation with the park and all other cooperators.

LITERATURE CITED

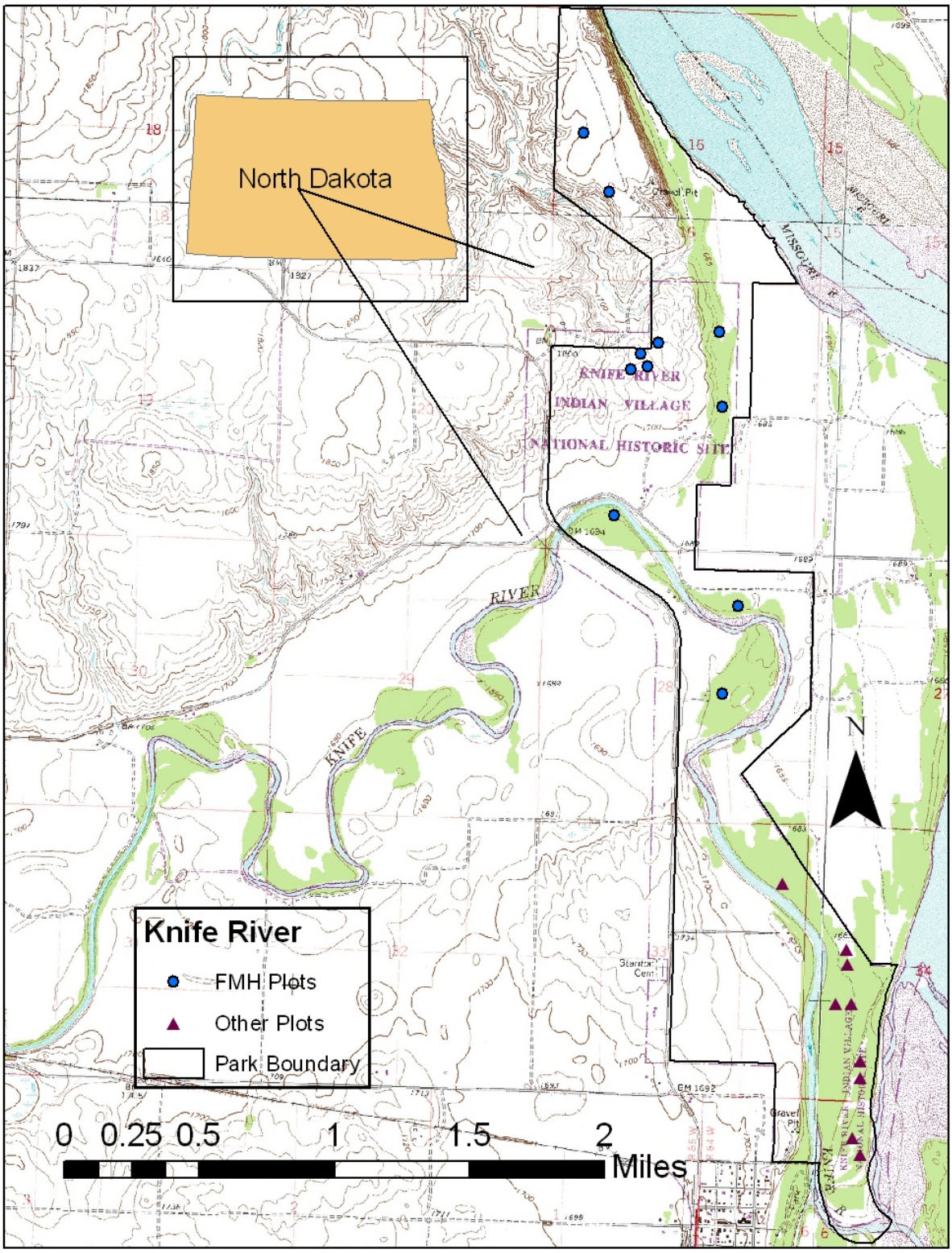
USDI National Park Service. 1998. Directors order #18: wildland fire management.

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.


North Dakota
KNIFE RIVER
INDIAN VILLAGE
NATIONAL HISTORIC SITE
MISSOURI R.
KNIFE
RIVER
N
Knife River
FMH Plots
Other Plots
Park Boundary
0 0.25 0.5 1 1.5 2
Miles

APPENDICES

APPENDIX 1 – MONITORING UNIT DESCRIPTION SHEETS

Monitoring Type Code: FRPE **Date Described:** 8/10/98

Monitoring Type Name: Green Ash -Box Elder Woodland

Prepared by: B. Kobza, K. Paintner, A. Thorstenson, A. Powers

Physical Description:
Riparian floodplain areas composed of level, deep, well-drained to moderately well-drained soils derived from alluvium of the Havrelon-Lohler series. Bottomlands and terraces associated with the Missouri and Knife Rivers. Elevation 1700-1670 feet.

Biological Description:
Woodlands composed of mixed age stands of green ash (*Fraxinus pennsylvanica)*, box elder (*Acer negundo*), American elm (*Ulmus americana)*, and peach-leaf willow (*Salix amygaloides*). Herbaceous ground cover dominated by non-native forbs and grasses including stinging nettle (*Urtica dioica*), Virginia wildrye (*Elymus virginicus*), and smooth brome (*Bromus inermis*). Other forbs and grasses include catnip (*Nepeta cataria*), damesrocket (*Hesperis matronalis*), bedstraw (*Galium boreale*), and pellitory (*Parietaria pennsylvanica*).

Selection Criteria: At least 50% canopy cover of green ash and box elder with an herbaceous understory.

Rejection Criteria:
Fewer than 6 overstory green ash per plot, cottonwood (*Populus deltoides*) greater than 20% of the canopy, Herbaceous layer composed of more than 30% Bromus inermis, areas less than 5 meters from roads, trails, or other man-made clearings

Burn Prescription:
It is preferred to burn these units in the spring, between early-April and green-up.

Fire Prescritption Elements	
Relative Hunidity: **25-55 %**	Average Rate of Spread: **0-3 ch/hr.**
Temperature**: 30-85 F**	**Live Fuel Moisture:**
Average Mid-flame Winds**: 0-20 mph**	1-hour TLFM**: 6-14 %**
Fuel Loading**: 3-5 tons/acre**	10-hour TLFM: **8-15 %**
Average Flame Lenth: **Backing fire, 0.4-1.5 ft.**	100 hour TLFM**: 10-30 %**

Monitoring Variables (in order of importance) **:**

- Overstory mortality
- Dead and downed woody fuel load
- Cover of non-native and native herbaceous species.

Prescribed Fire Objectives:

Immediate Post Burn

- Reduce dead and downed woody fuels by 30-50% immediate post-burn

Two Years Post Burn

- Limit overstory mortality to 10-20%.
- Reduce cover of non-native herbaceous species by 10-20%.
- Increase the number of seedling and pole-size native deciduous trees.

FMH-4 PLOT PROTOCOLS

GENERAL PROTOCOLS		YES	NO		YES	NO
Preburn	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**					
	*** see notes section.**					
Burn	Duff Moisture/Rec		•	Flame Zone Depth/Rec	•	
Postburn	Herbaceous Data/Opt: FMH - 17			Herb. Fuel Load/Opt		•
	100 Pt. Burn Severity/Opt		•			

FOREST PLOT PROTOCOLS		YES	NO		YES	NO
Overstory	Area sampled: 50 x20m			Quarters Sampled: Q1-Q4		
	Tree Damage/Rec	•		Crown Position/Rec	•	
	Dead Tree Damage/Opt		•	Dead Crown Position/Opt	•	
Pole-size	Area Sampled: 25 x10m			Quarters Sampled: Q1		
	Height/Rec	•		Poles Tagged/Rec		•
Seedling	Area Sampled: 5 x 10m			Quarters Sampled: Subset of Q1		
	Height/Rec	•		Seedlings Mapped/Opt		•
Fuel Load	Sampling Plane Length: 6, 6, 12, 50,50.			Fuel Continuity/Opt		•
	Aerial Fuel Load/Opt		•			
Postburn	Char Height/Rec	•		Mortality/Rec	•	

Monitoring Type Code: STCO **Date Described:** 7/28/97

Monitoring Type Name: Needle-and-thread/Sedge Mixed-grass Prairie

Prepared by: A. Powers, G. Bradshaw, B. Braudis, Bill Lutz, B. Adams, G. Kemp, R. Runge, Chas Cartwright

Physical Description:
Level uplands. Soil types include Mandan silt loam, 1-6% slopes, Temvik-Williams silt loam, 3-6% slopes and Zahl loam, 15-35% slopes.

Biological Description:
A mixed-grass prairie with dominant species: needle-and-thread (*Hesperostipa comata*), and threadleaf sedge (*Carex filifolia*). Common grasses species include: blue grama (*Bouteloua gracilis*), western wheatgrass (*Pascopyrum smithii*). Forbs include: fringed sage (*Artemisia frigida)*, and yellow owl's-clover (*Orthocarpus luteus*).

Rejection Criteria:
At least 20 meters from marked or unmarked sites of cultural significance. Areas mowed on a yearly basis Barren areas or sand bars >20% of the plot; areas with anomalous vegetation; monitoring type boundaries; riparian areas or areas dominated by trees; bio-control areas; areas within 20 meters of roads, man-made trails, or human created clearings are to be rejected.

Notes: Brush density will not be collected for *Opuntia polyacantha* because it is rhizomatous. Biomass will be collected at each plot just prior to the burn.

Burn Prescription:
This prairie will be burned between April until green-up, or Labor Day-end of September.

Fire Prescritption Elements	
RH: **25-55 %**	Average Rate of Spread: **0-3 ch/hr.**
Bulb**: 30-85 F**	**Live Fuel Moisture:**
Average Mid-flame Winds**: 0-20 mph**	1-hour TLFM**: 6-14 %**
Fuel Loading**: 3-5 tons/acre**	10-hour TLFM: **8-15 %**
Average Flame Lenth: **0.4-1.5 ft.**	100 hour TLFM**: 10-30 %**

Monitoring Variables (in order of importance**):**

- Cover of native perennial grasses and forbs
- Total brush density
- Plant community composition.

Prescribed Fire Objectives:

Immediate Post Burn

- Reduce thatch and litter layer.
- Burn over 85% of the burnable area.

Two Year Post Burn

- Increase native perennial grass and forb cover by at least 25%.

Fire Monitoring Objectives:

- Measure the cover of native perennial grasses and forbs with a sufficient sample size to be 80% confident that the sample mean will be within 25% of the population mean.

GENERAL PROTOCOLS		YES	NO		YES	NO
Preburn	Control Plots/Opt		•	Herb Height/Rec	•	
	Herbaceous Density/Opt		•	Belt Transect Width: 5 meters		
	OP/Origin Buried		•	Abbreviated Tags	•	
	Voucher Specimens/Rec	•		Stakes Installed: 0P & 30P		
	Stereo Photography/Opt		•	Crown Intercept/Opt		•
	Brush Individuals/Rec	•		Herb. Fuel Load/Opt	•	
	Herbaceous Data Collected at: 0P-30P					
Burn	Duff Moisture/Rec		•	Flame Zone Depth/Rec	•	
Postburn	Herbaceous Data/Opt: Collected.			Herb. Fuel Load/Opt	•	
	100 Pt. Burn Severity/Opt		•			

APPENDIX 2 - ALTERNATIVE SAMPLING PROTOCOLS

Abstract

These alternative sampling plots are intended to provide information on vegetative conditions in grassland areas. Data collected will provide occurrence, density, and frequency by species, lifeform, or native versus non-native.

Methods

Plots are randomly located using a G.I.S. application within a specific ecological community.
Plots consist of 20 Daubenmire frames, 3 nested frequency frames, and a complete list of observed species.
2 rebar are located at 0 meters and 25 (or 24) meters with a centerline run between them.
Plot azimuth is randomly determined.
Plot location is described with written directions from roads or trails, and global positioning coordinates are listed in UTM format datum NAD 83.
Complete list of species is created for the 25m x 10 m area (within 5 meters either side of the centerline).

Daubenmire frames are read beginning at 1m-1.2m,2m-2.2m,3m-3.2m…20m-20.2m

Daubenmire frames are placed on the left side of the centerline
Frames measure 20cm x 50cm
Each species is recorded and given a cover class 1 through 6

Nested frames are placed beginning at 1m-4.16m, 10m-13.16m, and 20m-23.16m

Nested frames are placed on the right side of the centerline
Frame sizes are 0.01 m^2 (10cm x 10cm), 0.1 m^2 (31.6cm x 31.6cm), 1 m^2 (100cm x 100cm), 10 m^2 (3.16m x 3.16m)
Presence of each species is recorded for each size interval

Data sheets created for a plot include:

FMH-5 Plot Location Data Sheet
FMH-6 Species Code List
Nested Frequency Data sheet
Daubenmire Data Sheet

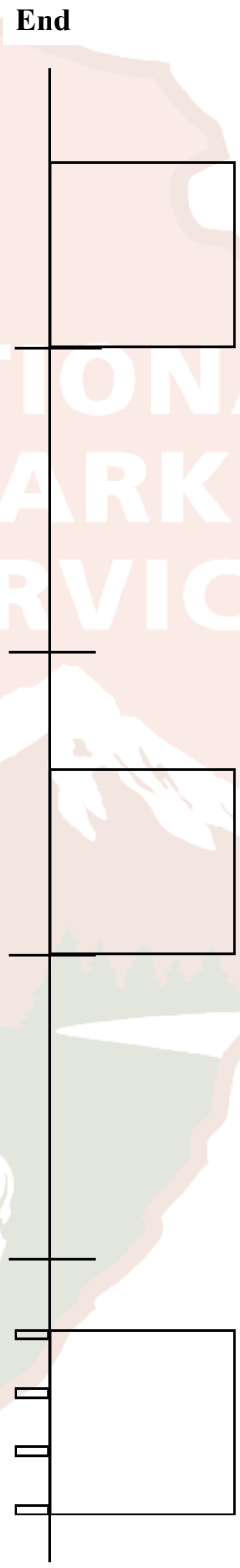
Equipment

2-30 meter tapes
Daubenmire frame(s)
Set of 3 increments of Nested frequency frames
4 Chaining pins for 10 m^2 nested frame
Set of 4 Data sheets
Plant identification guides

24 or 25 meter transect

Nested frequency plots read on the right side of the transect at 1-m, 10-m, and 20-m.

20 Daubenmire frames read on every meter from 1 to 20 meters.



Daubenmire Data Sheet

Park: _____ ___

Date:_____ _____

Plot ID: _____ _

Burn Unit: _____

Recorders: _____ __

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
TOCO																				
LITT																				
BARE																				
TOGR																				
TOFO																				
TOSH																				

1. 1-5%
2. 6-25%
3. 26-50%
4. 51-75%
5. 76-95%
6. 96-100%

APPENDIX 3 – LONG-TERM PHOTO MONITORING

LONG TERM PHOTO MONITORING SHEET

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

Burn Unit: _____ **Recorders: _____**

UTM Zone:_____	**Camera height: _____ft.**	**Elevation: _____ft**
UTMN:_____	**Lens size: _____mm**	**Slope along transect: _____%**
UTME:_____	**Distance from pole: _____ft.**	**Slope of terrain: _____%**
Datum:_____	**Azimuth from camera to pole: ____**	**No. of Photos Taken: _____**
EPE:_____	**Height on pole used for shot: _____ft**	**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	FEAT ID	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Big Hidatsa	Green Ash	FRPE-01		V											
Big Hidatsa	Green Ash	FRPE-03			V										
Big Hidatsa	Needlegrass	STCO-03		V	V/B	V	V			V	V/B	V			V
Big Hidatsa	Needlegrass	STCO-04		V	V/B	V	V			V	V/B	V			V
Big Hidatsa	Needlegrass	STCO-05		V	V/B	V	V			V	V/B	V			V
Big Hidatsa	Needlegrass	STCO-06		V	V/B	V	V			V	V/B	V			V
Boneyard	Photo Point	KBPP1							V						
North Prairie	Needlegrass	STCO-01	V	n/a	V			V/B	V	V			V		
North Prairie	Needlegrass	STCO-02	V/B	V	V			V/B	V	V			V		
Peninsula	Brome	Rx-01						V/B	V/B	V			V		
Peninsula	Brome	Rx-02						V/B	V/B	V			V		
Peninsula	Brome	Rx-03						V/B	V/B	V			V		
Peninsula	Brome	Rx-04						V/B	V/B	V			V		
Peninsula	Brome	Rx-05						V/B	V/B	V			V		
Peninsula	Brome	Rx-06						V/B	V/B	V			V		
Peninsula	Brome	Rx-07						V/B	V/B	V			V		
Peninsula	Brome	Rx-08						V/B	V/B	V			V		
Peninsula	Brome	Rx-09						V/B	V/B	V			V		
Restoration	Grassland										V	V			
Sakakawea	Green Ash	FRPE-02			V		V/B	V	V			V/B	V		
Sakakawea	Green Ash	FRPE-04			V		V/B	V	V			V			
Sakakawea	Green Ash	FRPE-05			V		V/B	V	V			V			