A PROGRAM FOR MONITORING VEGETATION CHANGES IN RESPONSE TO PRESCRIBED BURNS AT DEVILS TOWER NATIONAL MONUMENT, WYOMING

Prepared for the National Park Service,
Devils Tower National Monument,

by

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INTRODUCTION

Devils Tower National Monument (DTNM), administered by the National Park Service, is located in the northeast corner of Wyoming on the western margin of the Black Hills. Although only 1347 acres in size, the Monument includes many of the vegetation types common to the region: grasslands, ponderosa pine forest, deciduous woodlands and riparian communities.

Fire has been recognized as an important natural factor in the development and maintenance of these plant communities (Forde, Sloan and Shown 1984, Gartner and Thompson 1973, Wright and Bailey 1982). For example, burning has been shown to reduce pine invasion of grasslands, to lessen fuel loads in pine forests, and to enhance nutrient availability by accelerating breakdown of accumulated dead organic material. Periodic fires may also be useful in eliminating exotic plant species, such as Kentucky bluegrass (Steuter 1986) and sweetclover (Forde, Sloan and Shown 1984).

The importance of fire in maintaining healthy plant communities has not always been recognized. In the late 1800's, fire suppression became an effective policy in the Black Hills area. Changes in vegetation over the last 100 years (Shideler 1972) have been attributed to this human-caused decrease in fire frequency (Gartner and Thompson 1973). A fire history study of DTNM indicated that fire frequency has decreased significantly since 1900, presumably due to fire suppression (Fisher, Jenkins and Fisher 1987) . Return periods for area-wide fires increased from 19 years prior to 1900, to 42 years after 1900. Frequency of fires in the immediate Tower area showed a similar decrease.

Recently, land managers have recognized the need for periodic burning in maintaining both grasslands and forest, and prescribed burning is now used as a management tool. Several areas within DTNM have been treated through prescribed burning, including the grassland/ponderosa pine forest ecotone in the Fossil Hill area, and the ponderosa pine forest west of the main road and south of the West Road. A third burn east of the main road was aborted when conditions proved to be too dry. Aside from photographs, no data were collected to monitor vegetation changes in response to burning.

In 1988, DTNM contracted with the Wyoming Natural Diversity Database (WNDDB) of The Nature Conservancy (TNC) to establish a prescribed burn vegetation monitoring program. This report includes a description of the program, baseline data collected, and management recommendations.

METHODS

The study area, located in the northeast part of the Monument, is included in the North East Corner and Either Way Fire Management Units (Figure 1). It is underlain by the Permo-Triassic Spearfish Formation, and the topography is gently rolling with low ridges and intervening swales. The area is dissected by a few small draws. The soil is Nevee silt loam, a deep, well-drained soil that typically supports mixed-grass prairie communities (USDA Soil Conservation Service et al. 1983). Vegetation in the study area is mainly grassland, with local concentrations of young ponderosa pine. Deciduous thickets occur in the small draws. Two grassland communities were identified in this study:

1. ridge grasslands dominated by little bluestem, some bare soil exposed;

2. swale grasslands dominated by Kentucky bluegrass; cover generally 100%.

The monitoring program is designed to track pine mortality and changes in grassland composition, in response to fire. The study area was divided into burn and control sections. Two stands of each grassland community were located in each section for a total of eight grassland stands. Data on frequency of occurrence of plant species at 50 sampling points in each stand were collected using a stratified random design. A permanent 50 m transect (with rebar at the endpoints) was laid out through the center of the stand, and sampling points located a random distance perpendicular to the transect at each meter mark. Three nested quadrats (1.0 m^2, 0.1 m^2, and 0.01 m^2) were positioned at each sampling point, and species rooted in each quadrat recorded. Transect endpoints served as photo points (see slides in Appendix D.) All sampling was carried out from August 2 through August 5, 1988.

To track pine mortality in response to burning, three 50 m transects were established, using rebar as endpoints, in areas of recent pine invasion within the burn section of the study area (Figure 2). For each transect, 50 trees were selected, one every meter a random number of paces from the baseline. Trees were marked with numbered aluminum tags, and size class recorded. Transect endpoints served as photo points (see slides in Appendix D). Data were collected on August 6 and 7, 1988.

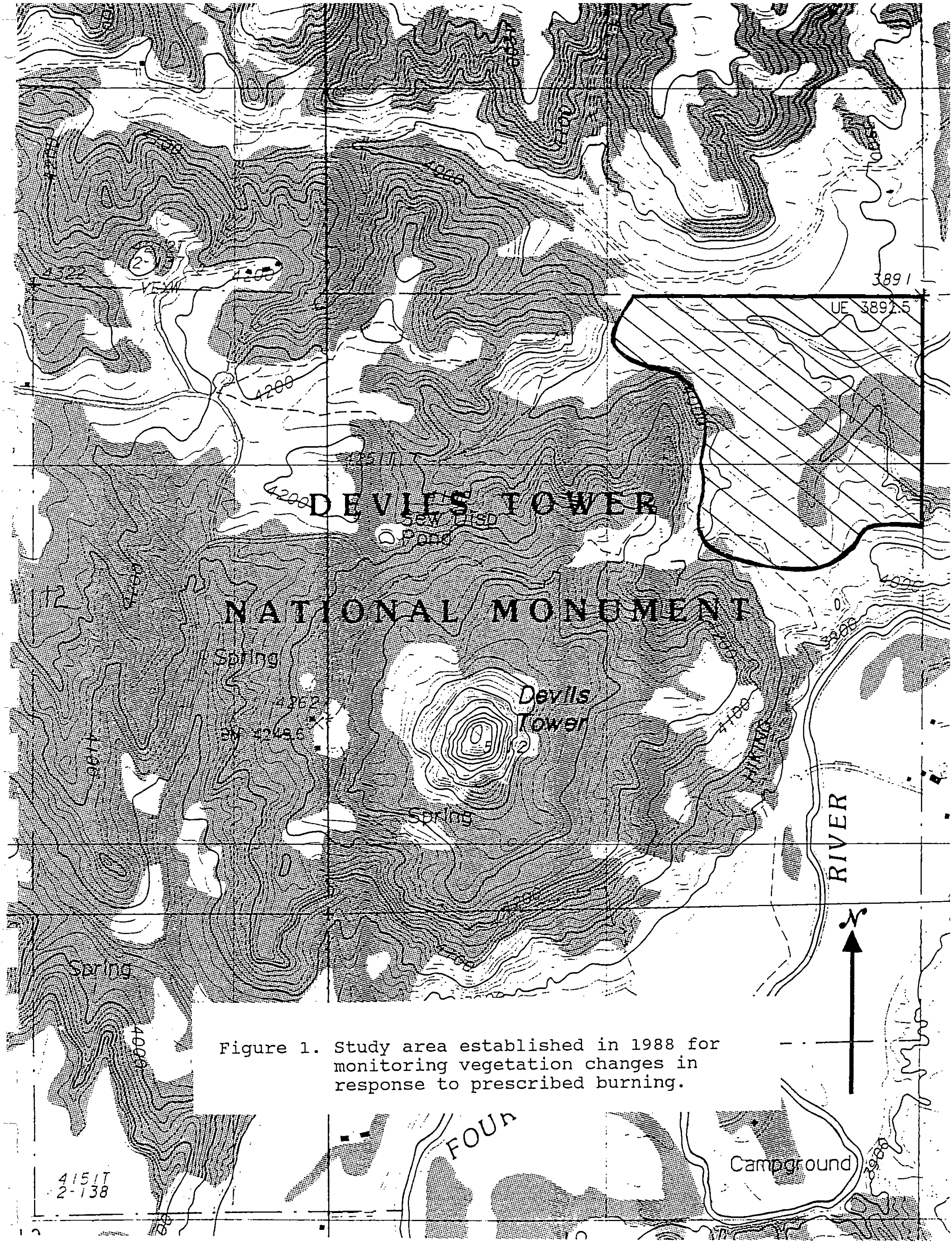

Figure 1. Study area established in 1988 for monitoring vegetation changes in response to prescribed burning.

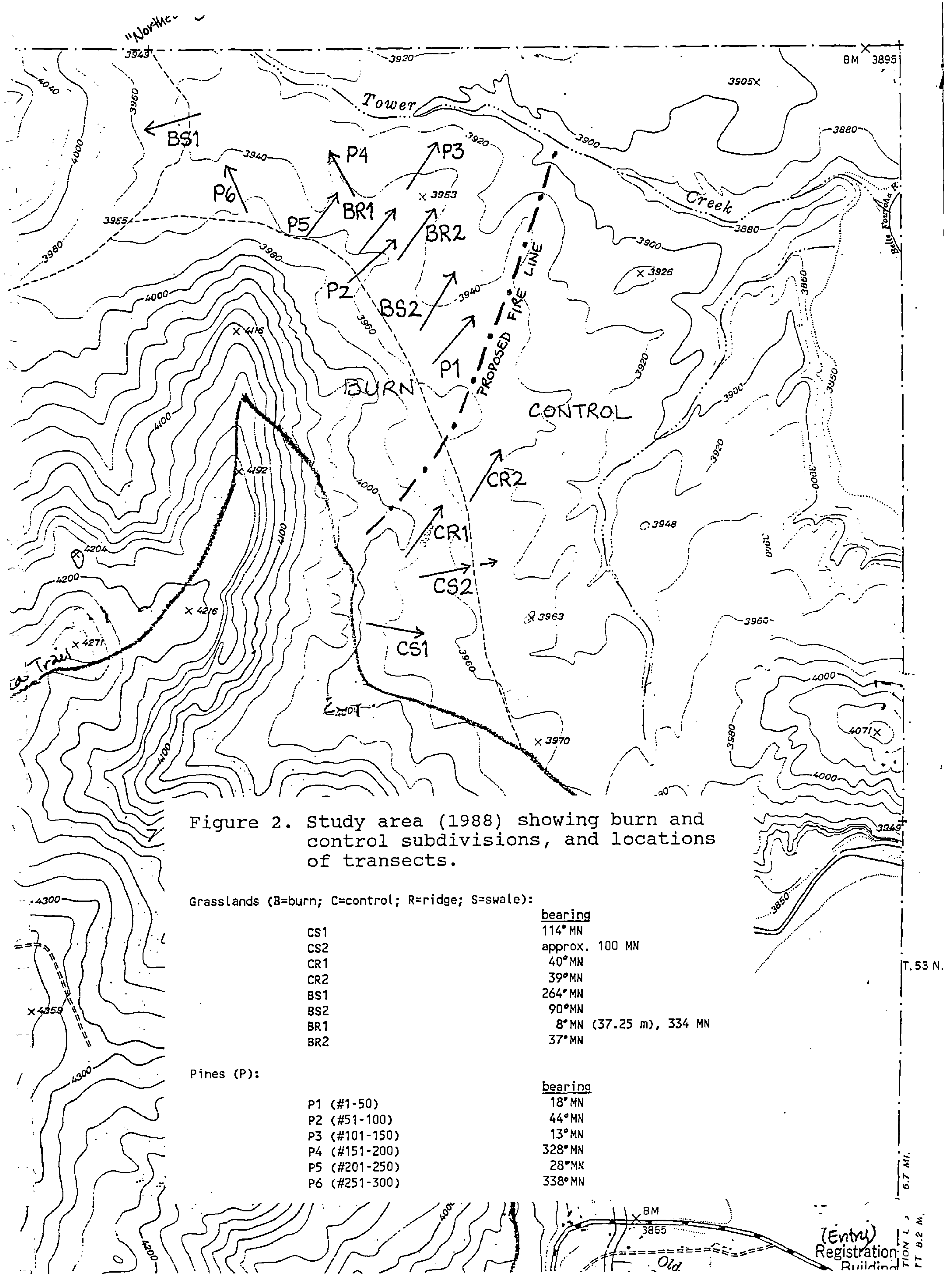

Figure 2. Study area (1988) showing burn and control subdivisions, and locations of transects.

Grasslands (B=burn; C=control; R=ridge; S=swale):

	bearing
CS1	114° MN
CS2	approx. 100 MN
CR1	40° MN
CR2	39° MN
BS1	264° MN
BS2	90° MN
BR1	8° MN (37.25 m), 334 MN
BR2	37° MN

Pines (P):

	bearing
P1 (#1-50)	18° MN
P2 (#51-100)	44° MN
P3 (#101-150)	13° MN
P4 (#151-200)	328° MN
P5 (#201-250)	28° MN
P6 (#251-300)	338° MN

RESULTS

Vegetation Data. The frequency data show differences in composition of the two types of grasslands of the study area (Appendix A). Three stands of ridge grasslands (Control Ridge #1, Control Ridge #2, and Burn Ridge #2) are similar to the Andropogon scoparius-Carex filifolia community described from the Custer National Forest of southeastern Montana (Hansen and Hoffman 1987). A. scoparius generally dominates the open vegetation, and C. filifolia is subdominant. Other important species are Andropogon gerardii (which has higher frequency than A. scoparius in Burn Ridge #2), Bouteloua curtipendula, Carex heliophila, Koeleria macrantha, Phlox hoodii, Artemisia ludoviciana, and Echinacea pallida. The fourth ridge grassland (Burn Ridge #1) resembles the Andropogon scoparius-Bouteloua curtipendula community described from the northern Powder River Basin (Terwilliger et al 1979). The vegetation is similar to the other ridge stands, but B. curtipendula is better represented than are the sedges. The swale grasslands can be classified as a Poa pratensis community. These stands are less diverse than the ridge grasslands, with dominance concentrated in the introduced bluegrass and a handfull of secondary species (Agropyron smithii, Stipa viridula, and Artemisia ludoviciana).

Baseline data for tagged ponderosa pines are presented and summarized in Appendix B. Size class was recorded for 300 trees (50 per transect):

A - less than or equal to knee height
B - greater than knee height and less than or equal to full reach (arm above head)
C - greater than full reach

Distribution of trees among size classes was as follows (P1-P6 are transect numbers):

Size Class	P1	P2	P3	P4	P5	P6	Total
A	14	18	2	15	25	33	107 (36%)
B	31	32	39	31	25	13	171 (57%)
C	5	--	9	3	--	4	21 (7%)

Climatic Data. Both 1987 and 1988 were drought years (Table A). However, precipitation was close to average through the 1987 growing season, dropping off sharply from October through November. In contrast, precipitation was significantly below average throughout the 1988 growing season. Precipitation from October 1987 through September 1988 was 10.70", 63% of the annual average. In addition, mean air temperatures were well above average during June and July, further aggravating drought conditions.

Table A. Climatological data for Devils Tower National Monument (National Oceanic and Atmospheric Administration 1987, 1988; Martner 1986).

TOTAL PRECIPITATION (INCHES)

	1987	1988	average for 1959-1980
January	0.47	0.47	0.65
February	0.75	0.43	0.61
March	1.76	1.58	0.78
April	0.18	0.53	1.93
May	2.91	2.13	2.76
June	1.20	1.06	3.23
July	2.19	0.79	1.61
August	2.68	0.67	1.53
September	1.38	1.99	1.47
October	0.36	N.A.	1.10
November	0.00	N.A.	0.64
December	0.50	N.A.	0.74
TOTAL ANNUAL PRECIP.:	14.38	****	17.05

AVERAGE AIR TEMPERATURE (F)

	1987	1988	average for 1959-1980
January	24.1	19.0	17.1
February	30.5	24.1	24.2
March	33.2	33.0	32.4
April	49.7	46.2	43.4
May	58.4	57.4	53.4
June	63.4	72.4	63.1
July	70.0	72.7	69.9
August	63.0	69.4	68.0
September	55.6	56.8	57.7
October	42.0	N.A.	46.2
November	36.5	N.A.	31.3
December	24.1	N.A.	22.2
AVERAGE ANNUAL AIR TEMP.:	45.9	N.A.	44.1

NOTES--

N.A.: data not available at time of writing

****: Total precipitation from October 1987 through September 1988 was 10.70 inches, 63% of the average annual total reported for 1959-1980.

DISCUSSION AND RECOMMENDATIONS

Integration of prescribed burning into Monument management is recommended for several reasons. Fire has been shown to be an effective tool in maintaining grassland communities, through reduction of pine invasion, acceleration of nutrient cycling, and reduction of exotic species. In forests, periodic burning can reduce fuel loads and the risk of uncontrolled fires. From an interpretive perspective, a prescribed burn program can be used to educate visitors about the importance of fire in shaping the vegetation component of the landscape.

Effective fire management requires monitoring programs to assess changes in vegetation in response to fire, and to evaluate whether management objectives are being met. The program established in 1988 was designed from a management perspective--to monitor changes in vegetation in a cost-effective manner--rather than for research purposes. For example, sampling was not adequate for generating statistically-valid estimates of community composition. If results indicate a need for greater insight into the mechanics of vegetation shifts, more intensive sampling would be required.

Drought and Data Adequacy. The study provided pre-burn baseline data for tracking species composition changes in grassland communities, and pine mortality in areas of recent pine invasion into grassland. The drought conditions of 1988 may have affected the adequacy of the data for establishing baselines. Specifically, species composition of the grassland communities probably was affected by the drought. Frequency data are less likely to be influenced than measurements of production, such as cover. However, drought conditions may favor certain species sufficiently to reduce the frequency of others. Production for minor components of the communities, such as forb species, also may be reduced enough to affect frequency data. Evidence of reduced forb production was seen during the 1988 sampling. Many of the common grassland forbs were rare or present only in vegetative form.

Continued Monitoring. Monitoring should be done annually following the prescribed burn, using the methods described above. Late July through early August is the best time for sampling, as both cool-season and warm-season species are present and recognizeable. If no burn is carried out prior to August 1989, baseline data on grassland composition should be recollected, assuming that precipitation for the year is near average.

Additional Programs. Similar monitoring programs should be established in other areas of the Monument scheduled for prescribed burning. Joyner Ridge and the area north of the West Road adjacent to the west boundary of the Monument include large stands of mixed grass prairie and grassland/pine forest ecotone, and could be easily divided into burn and control sections for assessing fire effects on these communities.

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