



Prescribed Fire Monitoring Report

George Washington Carver National Monument, 2012

(IQCS fire number: 00000222797, NFPORS number:3317828, -29, -32, -34)

Natural Resource Data Series NPS/HTLN/NRDS—2012/328



ON THE COVER

Juvenile cottontail rabbit escaped the fire.

Photograph by: Sherry Leis, Fire Ecologist filed in the HTLN archives.

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Acronyms

<u>Term</u>	<u>Definition</u>
AAR	After-action review
ATV	All terrain vehicle
FEMO	Fire Effects Monitor
FL	Flame length
FZD	Flame zone depth
GWCA	George Washington Carver National Monument
HTLN	Heartland Inventory and Monitoring Network
MDC	Missouri Department of Conservation
NPS	National Park Service
RH	Relative humidity
ROS	Rate of spread
Stdev	Standard deviation
UTV	Universal terrain vehicle

Burn Operations Summary

The southern prairie units (3, 4, 5, and 6) at George Washington Carver National Monument (GWCA) were planned to be burned on March 5, 2012. Dwight Newman bossed the burn with Shane Morey as burn boss trainee. These units were last burned in 2010 with the same objective of reducing invasive woody plants and enhancing native grassland species. A briefing was held at 1100 hrs in the visitor center parking lot and crews then proceeded to the test fire ignition site (NW corner of unit 6, Point F; Figure 1). Most units were burned using a ring fire technique where the fire is ignited on the downwind side of the unit and two crews progress in opposite directions towards the upwind or head of the fire. Units 3 and 6 were burned as a group followed by unit 4, west of the visitor center. Unit 4 was ignited at point H (Figure 1). Care was taken around the cemetery area. The strip between the trail along the tree row and unit 6 was burned after the main part of unit 4 was completed. Unit 5 was then burned with ignition beginning at the NW corner at point J. The NW corner of 5 was stripped out followed by ring fire ignition for the remainder of the unit. Unit 5 was tied up at point B at 1413 hrs. Burning was completed about 1430 hrs and mop-up commenced. All units planned for the day were completed. Winds were consistent with light gusts throughout the day allowing for a complete burn and variable fire intensities. An after action review (AAR) was conducted at 1500 hrs, but the author was not present. Participants elucidated communication problems such as difficulty transmitting to park headquarters and the local park radios could not be programmed to communicate with the module's radios.

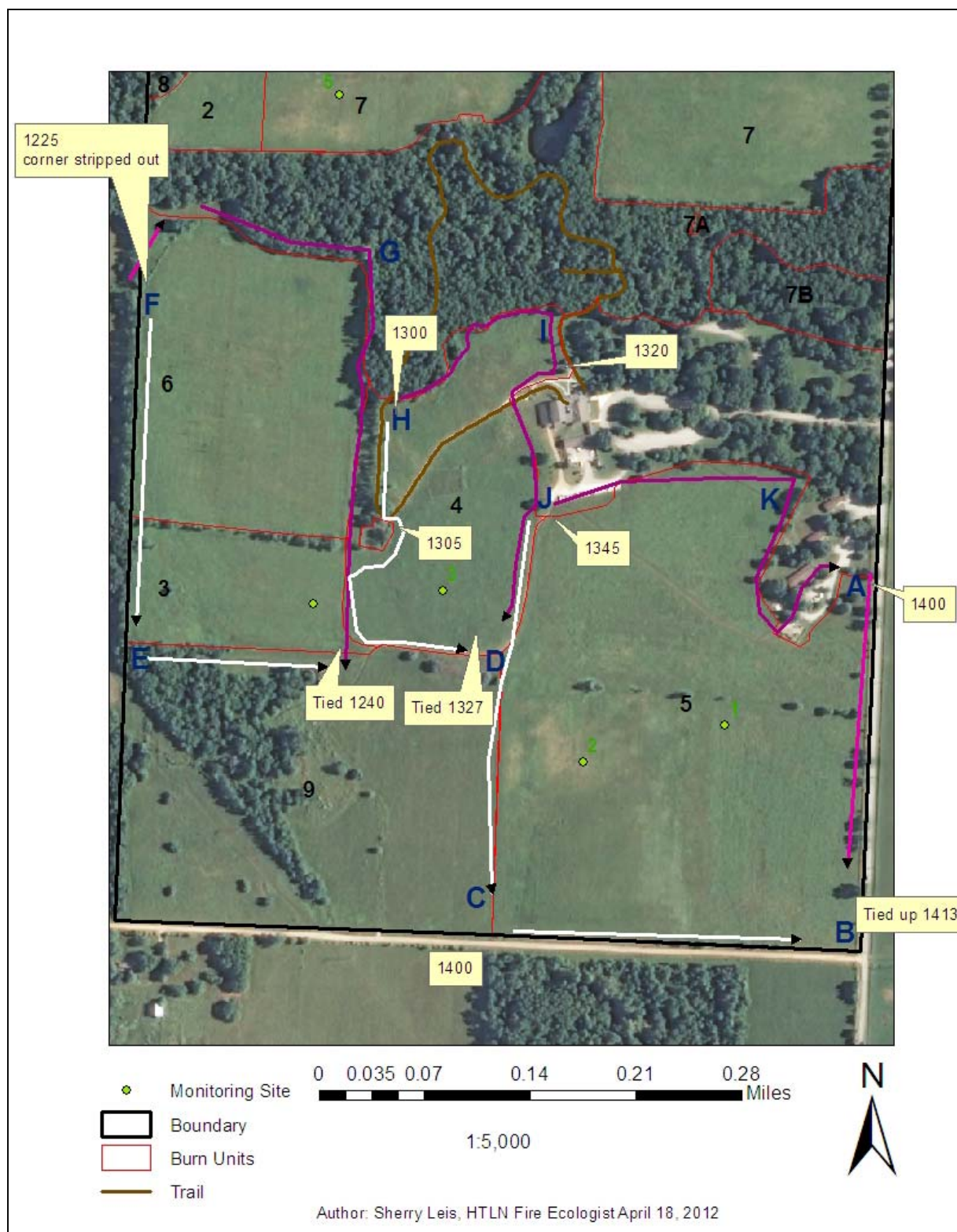


Figure 1. Ignitions progression for burn operations at George Washington Carver National Monument March 5, 2012. Burn units 6 and 3 were burned together while units 4 and 5 were ignited as individual units. Pink arrows indicate north crew progression while white arrows indicate south crew progression.

Burn Unit Measurements

Date: 03/5/2012

Unit: (south prairie). Units 3, 4, 5, and 6 were last burned in 2010.

Size: Planned acres = 84, Actual acres burned = 78

Vegetation type: Tallgrass prairie (fuel model 3)

Personnel: The local fire department was also on hand to monitor the burn in addition to the personnel listed below.

- Burn Boss: Dwight Newman, Shane Morey Burn Boss Trainee
- FEMO: Sherry Leis
- North: Line Boss Tim Baron
Cody Miller, Chris Reed, Adam Throckmorton, Pat Marlow
- East: Line Boss, Josh Hampton
Joe James, Lewis Bernier, Gary Ferguson, and Kyle Ellis
- Public safety: Curtis Gregory and park staff alerted motorists of smoke hazards.

Objectives (Objectives listed are from the prescribed fire plan (Mier and Morey 2010).

Resource objectives:

1. Encourage growth of native species by 5 – 10%.
2. Control and diminish exotic species by 5 – 10%.

Prescribed fire objectives:

1. Reduce dead and down fuels (1 & 10 hour fuels) by 20 – 50%.
2. Reduce dead and down fuels (100 & 1000 hour fuels) by 1 – 5%.

Tolerable deviation of objectives:

Treat (blacken) 75 to 95% of individual burn units. A mosaic of fire intensity and severity is acceptable and desirable.

Table 1. Selected environmental prescription elements for fuel model 3 (tallgrass prairie). The full prescription can be found in the burn plan (Mier and Morey 2010).

Variables	Acceptable	Preferred
Temperature (°F)	20-100	70
Relative Humidity	18-75	30
Wind direction	All	SW
Wind Speed (midflame, mph)	0-8	4
Fuel moisture (%) 1-hour	3-12	7
Fuel moisture (%) 10-hour	6-15	8
Live fuel moisture (%)	50-300	75

Table 2. Selected fire behavior prescription elements for fuel model 3. The full prescription can be found in the burn plan (Mier and Morey 2010).

Variable	Cool	Hot	Desired
Rate of spread (ch/hr)	28.1	291	82.8
Flame length (ft0	6.5	22.2	11.8
Probability of Ignition (%)	25	89	59

Methods

Sampling methods for fire ecology monitoring are described in detail in a published protocol available at http://science.nature.nps.gov/im/units/htln/library/Fire/FireEcol_2011_p.pdf (Leis et.al. 2011). Monitoring sites were distributed in burn units 3, 4, and 5 (Figure 2). Four established vegetation monitoring sites were used for this fire effects monitoring event (VegMon sites 1, 2, 3, 4). Pre-burn fuel load and photopoint monitoring was conducted December 08, 2011. We expect a 10-20% degradation of the fuel bed over the winter months; however, the anticipated degradation is within the measurement error and not likely to affect the results. Fuel and soil moisture monitoring was completed the morning of the burn. Burn day weather (included temperature, humidity, wind, and calculated fuel moisture and probability of ignition) as well as fire and smoke behavior measurements were collected by Sherry Leis.

Post-burn fire severity and photopoints were collected post-burn on March 5th. GPS collection of the burn unit perimeter was completed by HTLN staff (Figure 2). Minimum mapping units were set at 0.5-acre (SOP 3, Leis et.al. 2011). Burn perimeters were driven (UTV) and interior unburned patches were collected on foot. GPS coordinates were taken using a Trimble Nomad. The coordinates were recorded in a geodatabase.

Mean fire severity rankings for each site were used to infer fuel reduction. Proportions of categories for severity were assigned a fuel reduction percent and the sum for all the sites was converted to percent. Substrate fuels (litter, duff, soil surface) considered to be eliminated were in severity class 1, 2, and 50% of class 3. Vegetation fuels (standing plant matter) in severity class 1, 2, and 75% of class 3 were considered eliminated. The sum total for all sites was converted to a percentage for both substrate (litter and duff) and vegetation (standing fuels) to infer fuels reduced.

Results

Fuel Load

The mean fuel load was less than during the previous monitoring period for these units in 2010 (2.7 tons/acre $\pm$ 0.7 stdev; Table 3). Fuels were primarily dead as most plants had not yet initiated spring growth.

Table 3. Mean fuel load values by burn unit. Fuel load includes standing live, standing dead as well as litter and duff.

Site	N	Mean ton/acre	Stdev (ton/acre)
01	4	1.9	0.6
02	4	2.0	1.4
03	4	1.0	0.2
04	4	1.9	0.8
Park	4	1.7	0.8

Soil Moisture

Soil moisture is most likely to influence litter/duff moisture and moisture content of green fuel. Soil moisture prior to the 2012 burn was at field capacity for plant available water (Table 4). This indicates that growing plants had adequate available water at the time of the burn. The soil was damp to the touch, but not saturated.

Table 4. Soil moisture. Volumetric soil moisture of 50% is considered a saturated condition, while 25% is the field capacity for plant available water and 10% indicates the permanent wilting point for plants.

Site	N	% volumetric moisture	Stdev
01	4	31.1	3.0
02	4	26.2	4.7
03	4	22.7	0.9
04	4	25.6	3.5
Park	4	26.4	4.3

Fuel Moisture

Average one-hour fuel moisture of standing fuels was within range of the prescription (Table 1). Litter moisture was a few percentage points greater than the acceptable moisture levels given in the prescription (Table 5). Moisture of extinction of dead 1-hr fuels for fuel model 3 is considered to be 25% indicating that the fuels were likely to burn (National Wildland Coordinating Group 2006).

Table 5. Fuel moisture samples included both live and dead materials from the standing and litter portions of the fuel bed.

Site	N	Litter % moisture (stdev)	Standing % moisture (stdev)
01	3	25.2 (3.7)	13.5 (1.2)
02	3	19.7(3.2)	13.9 (0.4)
03	3	13.7 (2.1)	10.2 (0.4)
04	3	15.8 (2.4)	9.8 (0.7)
Park	4	18.6 (5.2)	11.9 (2.1)

Weather Observations

Even though drought conditions occurred during the summer months of 2011, precipitation was slightly greater than the thirty year average 61.80 in (59.9 in long-term average). Heavy precipitation was recorded in February and April, but less than one inch was recorded in June. (National Climatic Data Center 2012).

Weather elements remained within prescription throughout the burn (Table 1). Lower than preferred relative humidity during the burns indicated that grass fuels would be receptive to burning with potential for spot-overs. Wind speeds were in the preferred range, but gusts were stronger than the preferred prescription. Wind gusts served to cause temporary increases in fire behavior. Probability of ignition was in the desired range.

Table 6. Weather observations.

Time	Location	Temperature		Dew Point	RH	Wind		Fine dead fuel moisture (Unshaded) %	Prob. Of Ignition %
		Dry	Wet			Speed	Direction		
0830	Visitor center	40	35	28	61	2 (5)	SE	13	20
0930	S prairie	48	39	26	43	5 (8)	SE	9	30
1000	S Prairie	51	41	28	41	3 (5)	E	8	40
1100	Visitor Center	53	41	24	32	3 (6)	E/SE	6	50
1130	Test fire	59	44	24	26	5 (8)	S/SW	6	50
1250	South side of unit 4	60	44	22	23	3 (8)	E/SE	5	60
1350	West side of unit 5 in mowed area	65	48	29	25	4-5 (10)	SE	6	50

Smoke Observations

Smoke did not inhibit activities on the fireline. During the burn a vertical smoke column formed pulling smoke from the firelines and making it easier for operations crews (Table 7). The smoke column reached predicted transport winds (mixing height 2000 ft maximum) allowing for good smoke dispersal through most of the day. Smoke did not appear to impede roadways, but park staff did post signs on Carver Rd to alert motorists.

Table 7. Smoke observations.

Time	Location	Elevation of smoke column	Smoke column direction	Smoke column description
1200	Test fire unit 6	Transport winds	NW	Smoke dispersed near surface
1240				Vertical column formed
1320	NW corner unit 5		NW	Solid column
1400	Unit 5, SW corner		NW	Good dispersal
1420	Unit 5, SE corner		NE	Column collapsing and falling to east

Fire Behavior

Fire behavior varied between the cool and desired ranges of the prescription (Table 2). Fire behavior varied in concert with wind gusts (Table 8). During the light gusts, flame lengths, and rates of spread were greater than during the intermittent periods. Some rotating flames were seen during ignition of unit 6/3. Rates of spread and fire intensities varied from the prescribed cool to hot ranges (Table 2) depending on whether the fire was backing or a head fire. Flame lengths were in the cool range of the prescription.

Table 8. Fire behavior. All fuels were tallgrass prairie model 3. Intensity was calculated using the formula $3(10FH)^2$. However, flame length (FL) was substituted for flame height (FH; flame height was not recorded). Rate of spread (ROS), Flame zone depth (FZD)

Time	Location (Unit)	Spread direction	ROS (Ch/hr)	FL	FH	FZD	Intensity (Btu/ft/s)
1200	Test fire	B	1.8	2	1	0.5	32.2
1215	Unit 6, north	H	54.5	7-13	6-12	4	1360.7
1320	NW corner Unit 5	H		4	4	3	128.8
1400	W side, unit 5	B	5.5	<1	<1	1-2	8.1
1415	SE side, unit 5	H	54.5	4-6	4-5	4	289.9

Fire Severity

Overall fire severity, based on assessment of the standing fuels was moderate while fire severity, based on the substrate (litter, duff, and soil surface layers), was light (Table 9). Moderate standing severity is defined by vegetation with unburned grass stubble less than 2 in tall, plant bases are burned to ground level and obscured in ash immediately after burning. Light substrate severity is defined by litter and duff that is only blackened to partially consumed. The higher moisture of substrate fuels (Table 5) may have resulted in the lower severity on substrate fuels.

Table 9. Fire severity values by site (standard deviation). N = number of samples.

Site	N	Mean severity class - Vegetation	Mean severity class - Substrate
01	32	1.9 (0.9)	3.1 (0.6)
02	32	2.1 (1.3)	3.2 (0.8)
03	32	2.4 (0.6)	3.2 (0.5)
04	32	2.2 (0.4)	3.0 (0.4)
Park	4	2.2 (0.9)	3.2 (0.6)

Severity classes: 0 = NA, 1 = heavy, 2 = moderate, 3= light, 4 = scorched, 5 = unburned

One hour fuel reductions exceeded the goal for standing fuels and substrate fuels were within the expected range (see objectives section). Substrate fuels in the burned units were reduced by 44% and vegetation (standing) fuels were reduced by about 88%. Fuel reduction was inferred by calculating proportions of data in fire severity classes (see methods). The values for substrate and vegetation cannot be combined since the proportion of the fuel load contributed by both elements is unknown. The proportion of fuel reduction calculations are indirect analyses and should be only applied as estimates.

Burn Extent

The burn units burned completely with only a few isolated locations remaining unburned (Figure 2). The goal of blackening 75-95% of the burn units was met with 92.4% of the area burned.

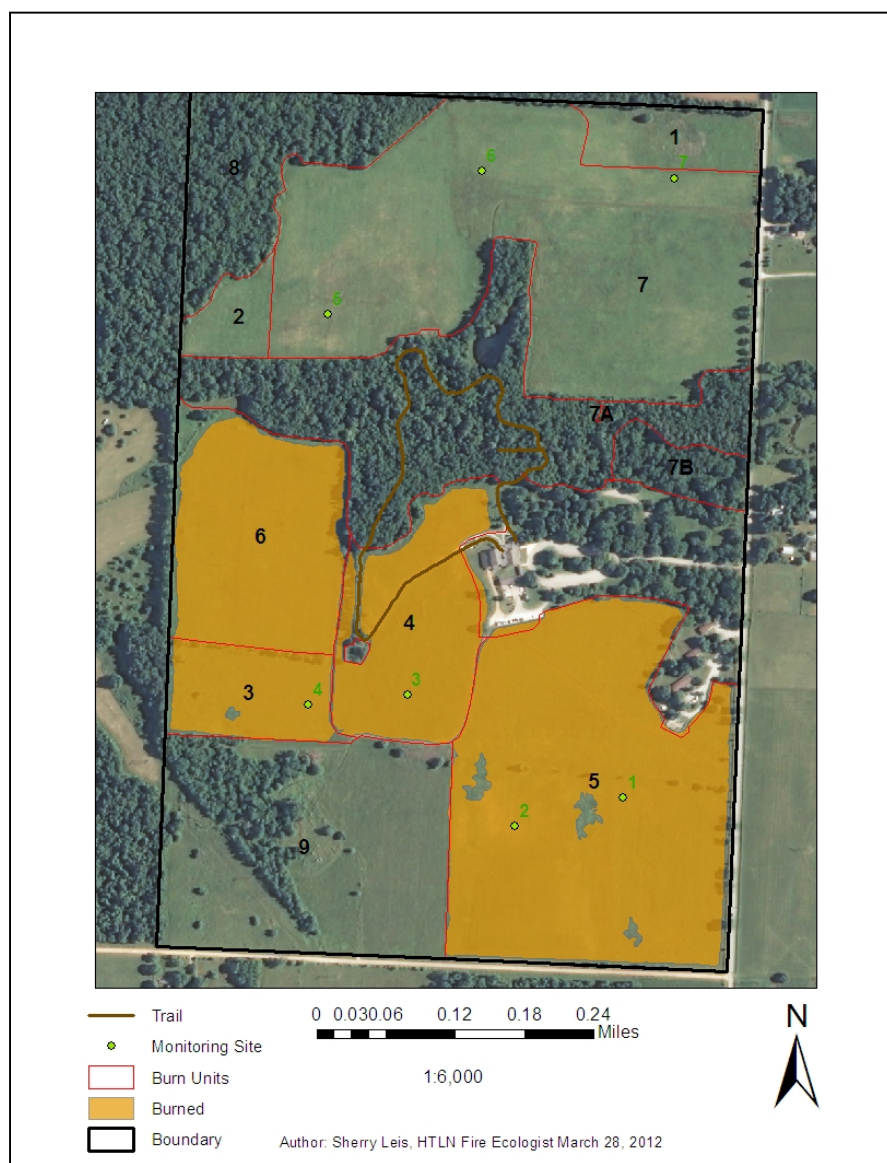


Figure 2. Area burned March 5, 2012 and monitoring sites at George Washington Carver National Monument. Data were collected with a Trimble Nomad GPS unit.

Summary

Fire effects monitoring is designed to evaluate whether a prescribed fire met the goals and objectives established in the Fire Management Plan, and more specifically the prescribed fire plan. Adaptive management can then be implemented using sound data and analysis (National Park Service 2008). Although not all the objectives stated in the prescribed fire plan (Mier and Morey 2010) can be evaluated with the data presented in this report, additional monitoring of plant communities by HTLN ecologists will address status and trends of the plant communities at GWCA (e.g., number of native and exotic species).

The prescribed fire on the south units of the prairie (3, 4, 5, and 6) at GWCA was successful in that firefighter and public safety were preserved. Weather along with ignition techniques allowed for good smoke dispersal and little impact on visitors or motorists. The operation was divided into three smaller units rather than burning all four as a single unit for logistical and safety reasons.

It is not possible to assess success of the burn on resource objectives in this report; however the HTLN vegetation and invasive species monitoring programs will address native plant and exotic plant abundances during scheduled monitoring in 2012. Additionally, the fire ecology program will assess woody shrubs and trees in the prairie by installing shrub monitoring belts in summer of 2012.

Precipitation influences soil and fuel moisture which in turn are reflected in fire behavior and severity. Moisture of extinction for one hour fuels is 25% (Simard 1968 in Miller 1994) and the mean fuel moisture was well below that point especially for standing fuels. The most recent precipitation prior to this burn occurred on February 29th yielding 0.4 in (NOAA 2012). Precipitation was below normal for the month, however. Actual fuel moistures (Table 5) were within the range of the 0830 and 0930 calculated fuel moistures (Table 6). Field samples were taken between 0830 and 1030 so subsequent calculated fuel moistures were influenced by increasing temperatures and lower relative humidity through the day.

Prescribed fire objectives focused on fuel reduction. Fuel loads may have been reduced from the 2010 fuel loads because of the 2011 drought (2010 precipitation was 44.98 in whereas, 2011 was 36.37 in (<http://ag3.agebb.missouri.edu/npsdata/>) and a short fire return interval of 2 years (Table 3). However, fuel loads were adequate to successfully conduct the burn. The goal of reducing 1- and 10-hour fuels by 20-50% was met for substrate fuels (44%) and surpassed for standing fuels (88%). These reduction percentages are estimates based on the severity data and should be applied with caution. No 100- or 1000-hr fuels were measured in the monitoring sites.

Based on our post-burn mapping, the objective to blacken 75-95% of the burn units was met with 92.4% of the area burned. The previous burn on these same units (2010) also met this objective but only burned 84% of the attempted area with most of the unburned area in unit 5. Furthermore, fire intensity did vary throughout the burns depending on the timing of wind gusts and point in the ignitions process. This variability may be reflected in the plant community in that plants in areas with greater severity are more likely to be top-killed (Bragg and Hulbert

1976, Briggs et al. 2005), or some seeds require heating for germination and may be differentially affected (Collins and Gibson 1990, Rohn and Bragg 1989), for example.

It is hoped that greater fire intensity will provide greater control of invasive species (e.g. smooth sumac, tall fescue) than a less intense fire. The fire intensity values (Table 8) are an indication of the energy produced (heat over time) in a given location. Fire severity (Table 9) is a manifestation of the fire's ability to consume fuel components. Average fire severity was moderate, but the variation observed in fire intensity (Table 8) was reflected in the severity measurements. Less severe effects on the substrate may be related to moderately moist soils. These units burned more severely and more completely than the previous attempt in 2010 (Cole 2010). Although fuel loads in 2010 were greater (2.7 tons/acre on average), fuel moisture was less in 2012. The 2010 burn occurred in September so the standing vegetation was expected to contain more moisture, but litter, the main fire carrier, was also wetter in 2010 (mean = 34% in 2010, 19% in 2012).

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Appendix-Sample Site Photographs



Figure 3. Pre-burn site 1 AS-AF.



Figure 4. Post-burn site 1 AS-AF.



Figure 5. Pre-burn site 2 AS-AF.



Figure 6. Post-burn site 2 AS-AF.



Figure 7. Pre-burn site 3 AS-AF.



Figure 8. Post-burn site 3 AS-AF.



Figure 9. Pre-burn site 4 AS-AF.



Figure 10. Post-burn site 4 AS-AF.



Figure 11. Fire behavior was mixed with both A. low intensity, and B. higher intensity occurring across the whole southern prairie.