



George Washington Carver National Monument 2015 Prescribed Fire Monitoring Report

Natural Resource Data Series NPS/HTLN/NRDS—2016/1015



ON THE COVER

Photograph of a hispid cotton rat (*Sigmodon hispidus*) in a shallow burrow immediately after the 2015 prescribed fire at George Washington Carver National Monument. Photograph courtesy of Sherry Leis, HTLN archives.

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Acknowledgments

We appreciate assistance from Kristen Kolhepp, and George Washington Carver NM for assistance in the field.

List of Terms

<u>Term</u>	<u>Definition</u>
FL	Flame Length
FH	Flame Height
FZD	Flame Zone Depth
GWCA	George Washington Carver National Monument
HTLN	Heartland Inventory and Monitoring Network
NPS	National Park Service
ROS	Rate of Spread
RH	Relative humidity
StDev	Standard deviation

Burn Operations Summary

The northern prairie (burn units 1, 2, and 7) were burned on October 21, 2015. These units were last burned in 2014. The rapid fire return interval was prescribed to continue to reduce woody plant encroachment. Ignition began in the NE corner of the park, point D, (unit 1) at 0950 (Figure 1). Crews blackened in that corner using stripping techniques then crews proceeded both to the west and south using a ring fire ignition pattern. A portion of unit 7, between points H and I, had previously been mowed requiring additional interior ignition. Crews met and completed ignition at the SW corner of unit 2. Ignition on the western third of the north prairie was timed to produce the most intense heat in a patch of ash and sycamore saplings that have been difficult to eradicate. Ignition was completed at point K at 1110. Mopup then commenced.

An after-action review (AAR) was conducted after mop up was satisfactory. It was noted that there were no unplanned safety concerns and burn lines were well prepared. The location for tying up the fire is not ideal because of the shape of the unit along the north tree line. Relocating a portion of the the north burn line in the woodland might be something to consider in the future (between points I and J). That spot has presented challenges in the past as well.

After the AAR, the monitoring team began post-burn assessments. The team was approached by the land owner to the north of the monument regarding slowly moving fire that entered his property just west of burn unit 1. Fire crews patrolling the burned area of the park were notified and quickly responded to extinguish any fire outside the burn unit.

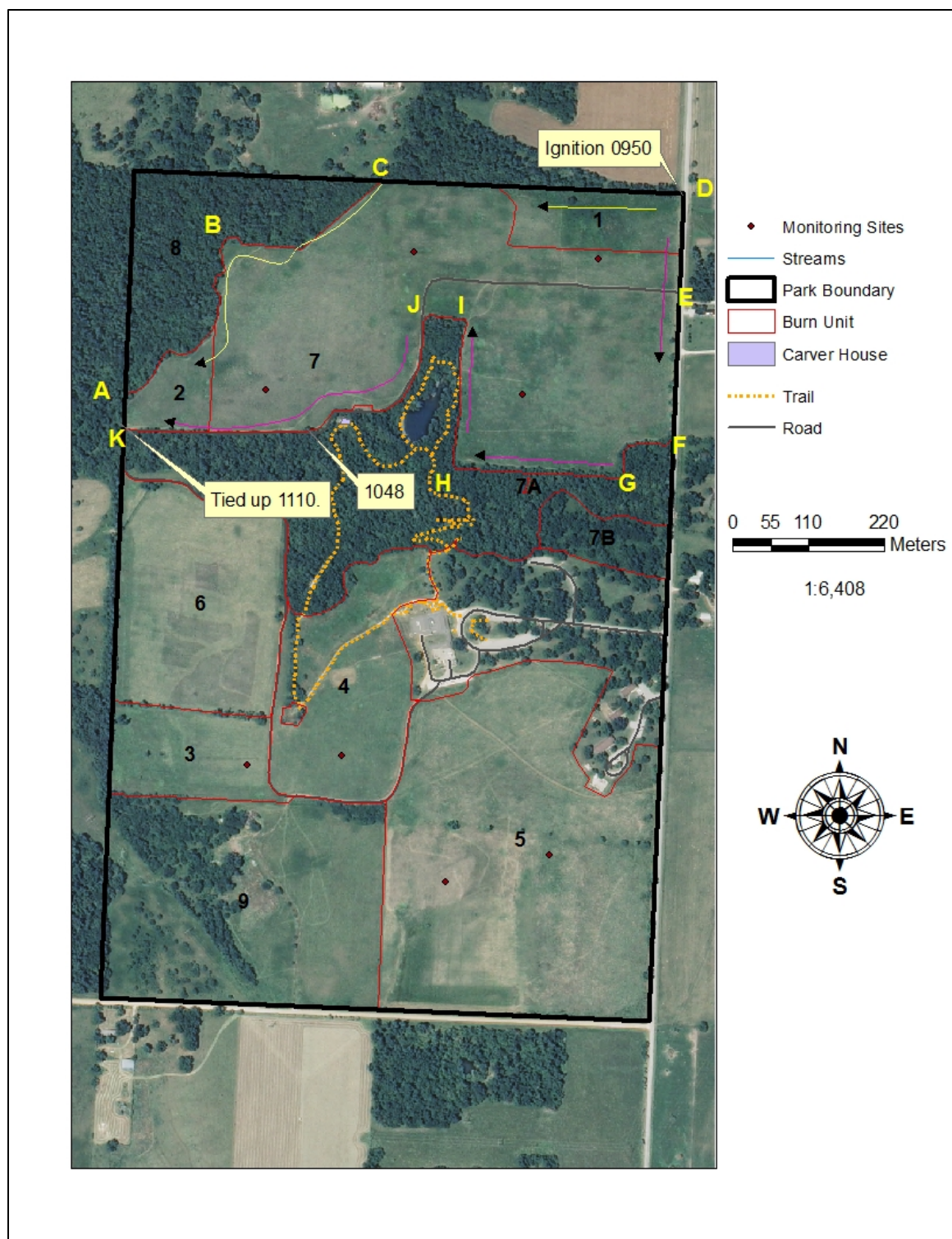


Figure 1. Progression of ignitions during a prescribed fire at George Washington Carver National Monument October 21, 2015. Holding team worked along the north line (yellow arrows) and ignition team worked along the east and south lines (pink arrows). Lettered points are referenced in data summary below.

Burn Unit Measurements

Date: 10/21/2015

Unit: North prairie burn block (units: 1, 2, 7) last burned in 2014.

Size: Planned acres = 58.6, Actual acres burned = 49.4 (84.3%)

Vegetation type: Tallgrass prairie (fuel model 3)

Personnel: Fire fighters from the Ozark National Scenic Riverways, GWCA, Heartland Inventory and Monitoring Network, and Buffalo fire module staffed the burn.

- Burn Boss: Scott Bressler
- FEMO: Sherry Leis
- Task force trainee, holding: Greg Carlson
- Fire boss east: Tim Baron
- Public safety: park staff alerted motorists of smoke hazards on the road.

Objectives:

The summary section will address how well the burn met these objectives. A new set of objectives was drafted in 2013, but the plan has not yet been updated. The objectives shown here are from the 2010 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 for George Washington Carver National Monument. The full prescription can be found in the prescribed fire 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 for George Washington Carver National Monument. The full prescription can be found in the prescribed fire plan (Mier and Morey 2010).

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

Methods

This report will describe the fuel and environmental conditions present for the prescribed fire on October 21, 2015 as well as the operation and results. We will put these assessments in context of the stated goals of the prescribed fire plan as well as previously monitored burns. Sampling methods for fire ecology monitoring are described in detail in a published protocol available from the [Heartland Inventory and Monitoring Unit](#) (Leis et al. 2011). Four monitoring sites were randomly distributed in the north prairie burn units so that the north prairie was assessed as a whole (Figure 1). Monitoring is conducted only within burn units planned to be burned in a given year.

Pre-burn fuel load and photopoint monitoring was conducted August 4, 2015. This included 3 vegetation monitoring sites and one virtual site (VegMon sites 5-7 and VF19). Fuel and soil moisture monitoring were completed the afternoon before the burn (October 20). Soil moisture was measured with a meter to avoid destructive sampling techniques. Burn day weather (including temperature, humidity, wind, calculated fuel moisture and probability of ignition) as well as fire and smoke behavior measurements were collected by Sherry Leis. Fire intensity was converted to BTU/ft/s for ease of communication.

Fire management at GWCA has focused on burning either the north or south prairie burn units together as blocks since 2000. In 2006, the current practice of burning half of the prairie (either north or south) every year, (i.e. a two year return interval), was implemented. The goal of this rapid fire return interval was reduction of woody plant encroachment. The data reported here can be used for future long-term analyses of vegetation and fuels.

Post-burn fire severity and photopoints were collected on October 21, 2015 immediately after the fire. Fire severity is measured using a categorical scale where 5 is unburned and 1 is severely burned (Leis et al. 2011). GPS collection of the burn unit perimeter was completed by Sherry Leis. Minimum mapping units were set at 0.5 acre (SOP 3, Leis et al. 2011). Interior unburned patches were collected on foot using a Trimble Nomad GPS unit while the perimeter was collected while riding an utility vehicle (UTV) and data were archived 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 percentage 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

Fuels were a mix of dormant native vegetation and live cool season grasses. Mean park fuel load (includes standing live, standing dead, as well as litter and duff) was 2.7 tons/acre (± 0.4 standard deviation; Table 3). This is within the range of fuel loads monitored since 2010 (1.7 — 2.8 tons/acre ± 0.4 — 0.8 stdev; Leis 2014). The characteristics of the fuel are similar to fuel model 3 on which the prescriptions have been based.

Table 3. Fuel load for George Washington Carver National Monument prior to October 21, 2015 prescribed fire.

Site	Mean Fuel Load (tons/acre)	Stdev	Notes
5	45.6		
6	62.5		
7	61.9		AF may have been impacted from the small scale brush burning in late 2014.
VF19	68.2		Collected prior to mowing.
North Prairie	2.7	0.4	

Soil Moisture

Soil moisture is most likely to influence litter/duff moisture and moisture content of live fuel. 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. Mean soil moisture the day prior to the 2015 burn was within field capacity ($11.5\% \pm 6.3$), but the standard deviation indicates that some patches in the matrix were below the wilting point for plants (Table 4). This means that growing plants may have been near stress levels for water availability and moisture in the litter and duff layers may have been most influence by ambient moisture rather than soil moisture.

Table 4. Soil moisture for George Washington Carver National Monument prior to October 21, 2015 prescribed fire.

Site	Mean soil moisture (% volumetric)	Stdev	Notes
5	7.8		
6	4.7		
7	17.7		
VF19	15.9		Previously mowed area
North Prairie	11.5	6.3	

Fuel Moisture

Average one-hour fuel moisture of $39.5\% \pm 20.7$ (Table 5) for fuels (standing and litter) was much greater than the prescribed level of 3-12% (Table 1). There was a great deal of variability in the data, however. Considering that samples included up to 50% live material, we can look at the live fuel moisture prescription as a guide. Our sampled values are below the Acceptable range of 50-300%. Moisture of extinction (predicts a reduction in fire behavior as fuel moistures approach the extinction value) of dead 1-hr fuels for fuel model 3 is considered to be 25%. At this fuel moisture level, fire behavior will be dampened as burning must overcome the moisture in fuels to continue to spread (National Wildland Coordinating Group 2006). Fine dry fuel moisture as calculated on the fireline, using standard tables in the Fireline handbook (see Leis et al. 2011 SOP 9), was quite a bit lower, 12-13 %, which is in line with the prescription (Table 6).

Table 5. Fuel moisture for George Washington Carver National Monument prior to October 21, 2015 prescribed fire.

Site	Mean fuel moisture (%)	Stdev	Notes
5	33.6		
6	13.4		
7	49.6		
VF19	61.2		Previously mowed area, sample consisted primarily of litter.
North Prairie	39.5	20.7	

Table 6. Weather observations collected during the prescribed fire at George Washington Carver National Monument on October 21, 2015. Windspeed values in () are maximum gust speeds.

Time	Location	Temperature			RH	Wind		Fine dead fuel moisture (Unshaded) %	Prob. Of Ignition %
		Dry	Wet	Dew Point		Speed (mph)	Direction		
900	Near staff parking lot	66	59	54	64	1.5 (3)	S/SE	13	20
1000	Between pts D/E	70	60	55	60	4 (8)	SW	12	20
1048	East of Carver House, S line	73	64	59	62	1 (5)	SW	12	20

Weather Observations

Nearly all weather parameters fell within the prescription with the exception of probability of ignition (Table 1, 6). Calculated and sampled 1-hr fuel moistures were on the moist end of the prescription with one value greater than Acceptable. Probability of ignition calculations were less than the cool fire intensity designation in the prescribed fire plan (out of prescription), however.

Smoke Observations

Smoke dispersal was adequate for avoiding hazards in the surrounding community (Table 7). Onsite, smoke was a challenge for holding crews along the north side of burn unit in the early stages of the burn.

Table 7. Smoke observations collected during the prescribed fire at George Washington Carver National Monument on October 21, 2015.

Time	Location	Elevation of smoke column	Smoke column direction	Fireline visibility	Comments
1010	Pt. D, east line	60.96	NE	poor on the north line	good dispersal, road moderately impacted
1100	West of Carver House, S line	152.4-304.8	NE	clear	

Fire Behavior

Mean rate of spread (ROS) and flame length (FL) were less than the cool range of 28.1 ch/hr and 6.5 ft., respectively (Table 2). Fire behavior at GWCA was generally in the cool range of the prescription (Leis 2014).

Table 8. Fire behavior. All fuels were tallgrass prairie model 3. Intensity (kW/m) was calculated using the formula $3(10FH)^2$ then converted to BTU/ft/s. Flame length (FL), flame height (FH), rate of spread (ROS), Flame zone depth (FZD).

Time	Location (Burn Unit)	FireType	ROS (Ch/hr)	FL (ft)	FH (ft)	FZD (ft)	Intensity (Btu/ft/s)
1002	Pt. D, east line	Flank	1.0	2	1	1	86.7
1010	Pt. E	Flank	6.4	3	3	3	780.0
1020	between Pt. C, D	Back	27.3	7	6	10	3120.1
1100	W of Carver House, S line	Head	13.6	5	5	3	2166.7
1110	Vegmon5	Head	9.1	5	4	3	1386.7
Mean		N=5	11.5	4.4	3.8	5.0	1508.03

Fire Severity

Overall, fire severity standing fuels and substrate fuels were very similar and fell in the Moderate to light range [standing fuels: ($\bar{x} = 2.5 \pm 0.4$, N=3), substrate fuels (i.e., litter, duff, and soil surface layers): mean = 2.8 ± 0.2 , N=4)]. Severity classes are the following: 0 = NA, 1 = heavy, 2 = moderate, 3 = light, 4 = scorched, 5 = unburned. Moderate standing severity is defined by vegetation with unburned grass stubble less than 2 in. tall, and plant bases burned to ground level and obscured in ash immediately after burning. Light substrate severity is defined as litter and duff that is only blackened to partially consumed

As flames moved through the small grove of ash and sycamore saplings in unit 7 west of the Carver House (monitoring site 05), we observed the fire crowning through the dried residual leaves in trees. The trees were also burned through at the bases (see Figure A9).

Fuel reduction

Only 1-hr fuels were assessed as no 100 or 1000 hour lag fuels were present in the unit. Substrate fuels across the park were reduced by about 60.1% and standing vegetation fuels were reduced by about 83.1%. Reduction of one-hour fuels exceeded the burn plan goal of 20-50%. 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 measurements and should be only applied as estimates.

Burn Extent

The burn units burned completely although there were a few areas that were patchy in nature (e.g. mowed area and recently burned area in unit 1; Figure 2). The goal of blackening 75-95% of the burn units was met with 49.4 acres (84.3%) of the area burned.

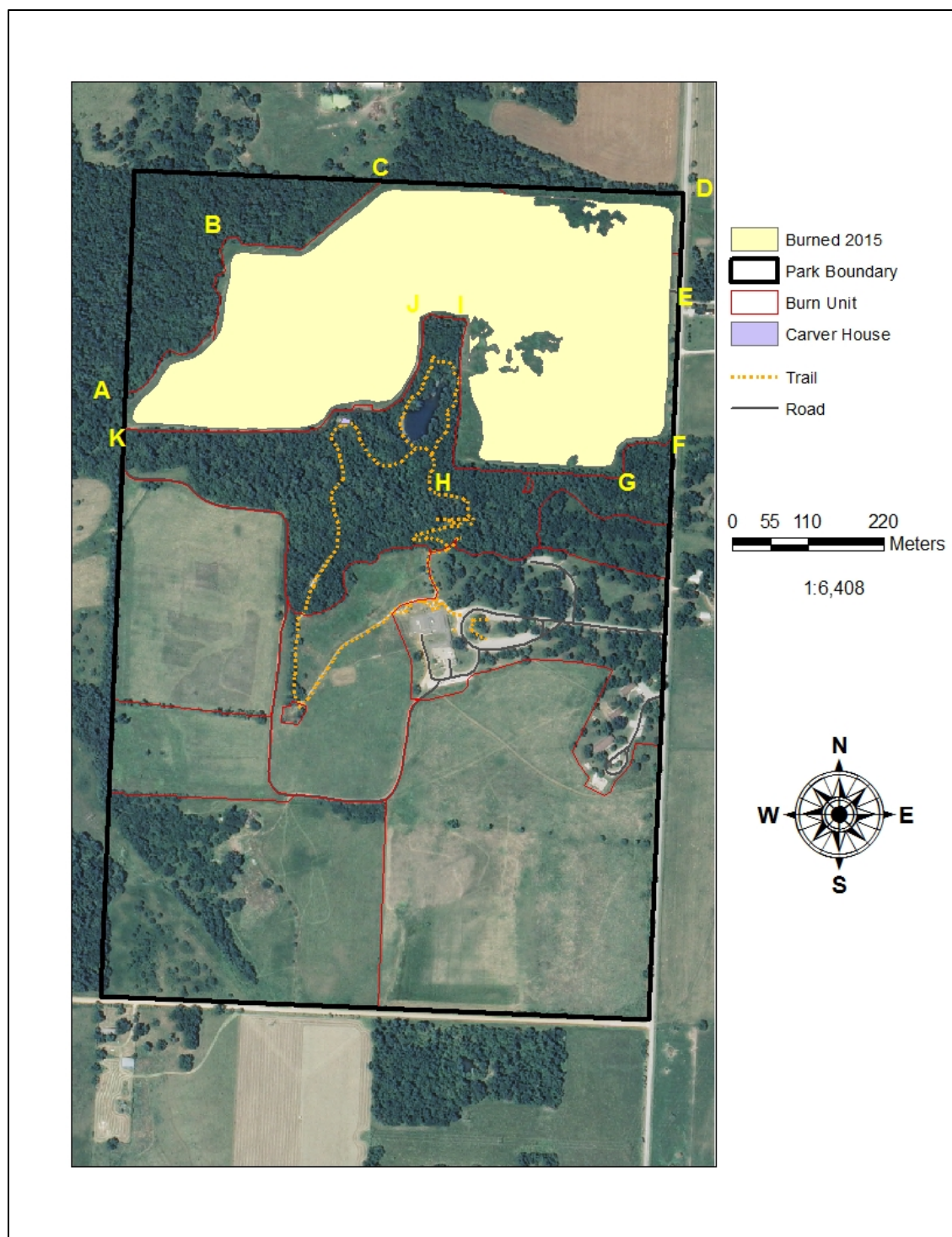


Figure 2. Area burned during a 2015 prescribed fire at George Washington Carver National Monument.

Summary

The prescribed fire at GWCA October 21, 2015 met safety objectives including smoke dispersal for the public and firefighters. Weather parameters stayed in prescription during the burn with the exception of probability of ignition which was less than prescribed. The green fuel component of the fuel matrix resulted in greater fuel moistures than prescribed. Moist fuel can reduce fire behavior. Fire behavior was primarily in the cool range of the prescription. At the time of the burn, green fuels were patchily distributed and may have reduced fire behavior from what may have occurred in a solid stand of cured fuels, for example Figure A8. Fire severity was moderate to light for standing vegetation and surface fuels. 1hr fuel reductions exceeded prescribed values. Future reports may look at the relationship of prescribed fires with vegetation goals such as woody plant and invasive species control.

Literature Cited

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- Leis, S. A., L. W. Morrison, J. L. Haack, M. S. Gaetani. 2011. Fire ecology monitoring protocol for the Heartland Inventory and Monitoring Network. Natural Resource Report NPS/HTLN/NRR—2011/294. National Park Service, Fort Collins, Colorado.

Appendix A. Monitoring photographs

Pre and post-burn photographs were taken of each of the four monitoring sites. An image from one of the two transects in each site is provided for reference.



Figure A1. Pre-burn photo of monitoring site 5 transect AS-AF at George Washington Carver National Monument.



Figure A2. Post-burn photo of monitoring site 5 transect AS-AF at George Washington Carver National Monument.



Figure A3. Pre-burn photo of monitoring site 6 transect BS-BF at George Washington Carver National Monument National Monument.



Figure A4. Post-burn photo of monitoring site 6 transect BS-BF at George Washington Carver National Monument National Monument.



Figure A5. Pre-burn photo of monitoring site 7 transect AS-AF at George Washington Carver National Monument National Monument.



Figure A6. Post-burn photo of monitoring site 7 transect AS-AF at George Washington Carver National Monument National Monument.



Figure A7. Pre-burn photo of monitoring site VF19 transect AS-AF at George Washington Carver National Monument National Monument.



Figure A8. Post-burn photo of monitoring site VF19 transect AS-AF at George Washington Carver National Monument National Monument. Much of this site had been mowed prior to the burn. Green patches of unburned fuel characterize the heterogeneity in this part of burn unit 7.



Figure A9. Post-burn photo of near monitoring site 05 transect at George Washington Carver National Monument National Monument. Leaves on these target saplings are curled from being scorched and the bases of the trees were burned as the fire moved through the area.

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