National Park Service
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Natural Resource Stewardship and Science

# Prescribed Fire Monitoring Report

*George Washington Carver National Monument, 2011 (IQCS fire number: 210511, NFPORS number 3317769, 3317778, 3317773)*

Natural Resource Data Series NPS/HTLN/NRDS—2011/205

**ON THE COVER**
Smoke in the prairie beyond the Carver House during a prescribed fire August 24, 2011
Photograph by: Dan Drees, Fire Ecologist.

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

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.



This report is available from Heartland Inventory and Monitoring Network http://science.nature.nps.gov/im/units/htln/fire.cfm and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/).

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## Acronyms

| Term | Definition |
|---|---|
| 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

Dwight Newman bossed the burn on August 24, 2011. An interagency crew including NPS, MDC, and the Forest Service was assembled to complete the scheduled burn. A briefing to describe the plan to burn the northern portion of the prairie at GWCA took place at 1030 hrs in front of the visitor center. Fuels were damp from a rain earlier in the week and RH values were high so ignition did not take place until 1130 hrs.

A ring fire technique was employed with the test fire taking place at the NE corner of the unit. Some stripping was done with an ATV torch throughout the unit, especially along the border of burn units 1 and 7 (NE prairie). Some stripping was also done along the NW part of unit 7. Air temperatures were high (Table 6) by the time the burn was finished and heat exhaustion was a concern. The fire was tied up at 1330 hrs and mopup took place until 1445.

During an after action review (AAR) participants noted that the north crew could have better communicated the critical points where fire was suppressed in or over the burn line. The greenness of the fuels helped the crew to keep the fire controlled by slowing down the burning. The fire crept in the mowed firebreak because of remaining chaff. Use of the ATV torch helped to build a sufficient black line along the perimeter more efficiently. Only one trip to fill up the engine with water was needed during the burn. Overall communications were deemed positive. One of the ATV torches failed mechanically, and one UTV needed maintenance during the burn.

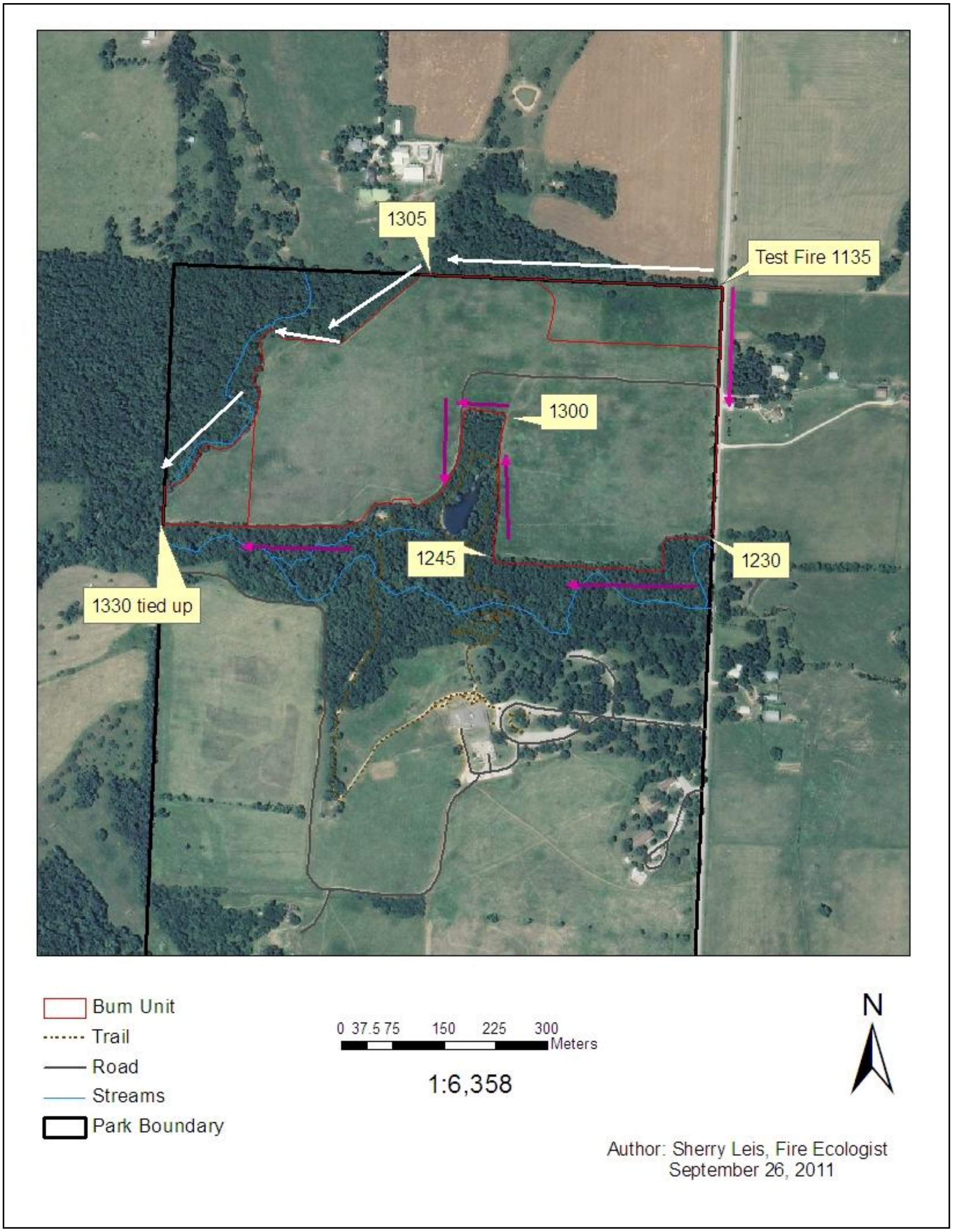


**Figure 1.** Burn progression for August 24, 2011. White arrows indicate path of north team and pink arrows indicate path of south team. Times of arrival are noted in yellow callouts.

## Burn Unit Measurements

**Date:** 08/24/2011

**Unit:** 1, 2, 7 (north prairie). Units 1, and 2 were last burned in 2007. Unit 7 was last burned in 2008.

**Size:** Planned acres = 53.6, Actual acres burned =53.6

**Vegetation type:** Tallgrass prairie (fuel model 3)

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

- Burn Boss: Dwight Newman
- FEMO: Dan Drees
- Monitoring: Sherry Leis, Chris Kopek
- North: Shane Morey, Line Boss
  Engine 862, Greg Carlson, Matt Brickner; UTV, Angela Sokolowski, Brittany Cole; ATV torch Kyle Ellis
- East: Cody Miller, Line Boss trainee, Tim Baron Line Boss
  Engine, Josh Hampton, Heather Bosserman; UTV, Pat Marlow, Curtis Gregory; ATV torch Shannon Clayborn
- Missouri Department of Conservation: UTV + 2 personnel

## Objectives

Objectives are listed 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 (ft) | 6.5 | 22.2 | 11.8 |
| Prob 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 throughout burn unit 7 (Figure 2). No monitoring sites were in units 1 or 2. Three established vegetation monitoring sites were used for this fire effects monitoring event (5, 6, 7). One additional virtual site was installed according to the protocol to increase the sample size (VF19). Pre-burn fuel load and photo monitoring was conducted July 13, 2011. Fuel and soil moisture monitoring was completed the morning of the burn. Burn day weather was collected by the designated FEMO (see Burn Unit Measurements section), but fire and smoke behavior measurements were collected by Sherry Leis and Chris Kopek. Post-burn fire severity and burn perimeter data were collected post-burn on August 26$^{th}$. The burn perimeter was collected using a Trimble Nomad GPS while riding an UTV.

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, while for 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 and vegetation (standing fuels) to infer fuels reduced.

# Results

## Fuel Load

Fuel loads were typical of tallgrass prairie in southwest Missouri. Although we did not measure litter separately from the rest of the fuel load, we did note a thicker litter layer at sites 5 and 6. This may be related to mowing treatments in the previous year (Figure 2). In the area of site 5, many saplings of ash and sycamore were present. Values only represent 1-hr fuels (Table 3). Other fuel lag classes were not present.

**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) |
|---|---|---|---|
| 05 | 4 | 2.2 | 0.8 |
| 06 | 4 | 3.4 | 1.7 |
| 07 | 4 | 2.9 | 1.0 |
| VF19 | 4 | 2.8 | 0.5 |
| **Park** | **4** | **2.8** | **0.5** |

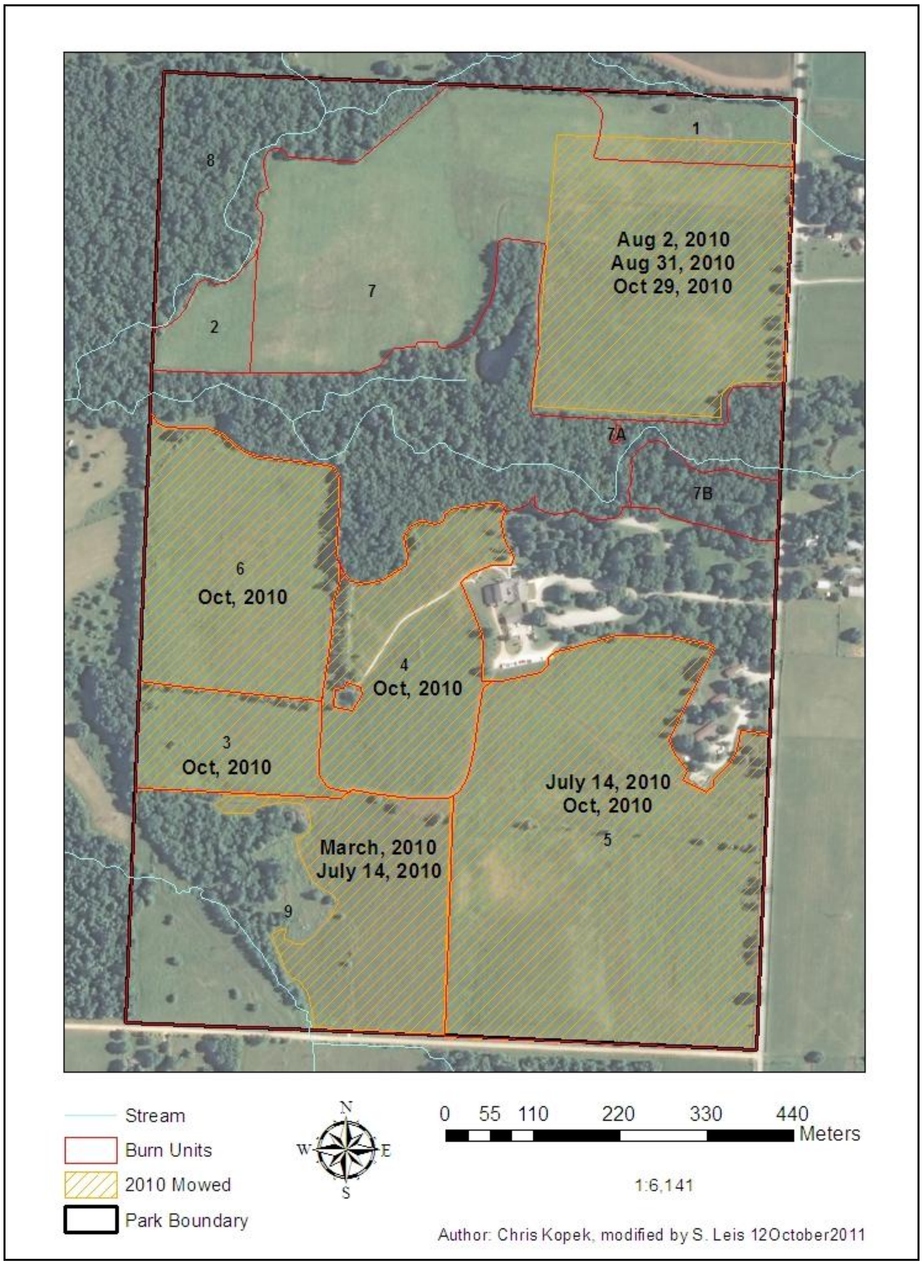


**Figure 2.** Areas of GWCA mowed in 2010. Dates of mowing are indicated.

## Soil Moisture

Soil moisture was below field capacity for plant available water (Table 4). This indicates that plants were likely to be stressed from drought conditions at the time of the burn.

**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 |
|---|---|---|---|
| 05 | 3 | 12.2 | 4.3 |
| 06 | 3 | 16.2 | 2.6 |
| 07 | 3 | 13.1 | 1.8 |
| VF19 | 3 | 11.7 | 3.3 |
| **Park** | **4** | **13.3** | **3.2** |

## Fuel Moisture

The 10-hr fuel moisture stick measured 11% in the acceptable range of the prescription the morning of the burn (Table 1). One-hour fuel moisture of litter and standing fuels were much greater than the acceptable moisture levels given in the prescription. Moisture of extinction of dead 1-hr fuels for fuel model 3 is considered to be 25% (National Wildland Coordinating Group 2006). The great amount of moisture was likely due to a rain during the week prior to the burn.

**Table 5** Fuel moisture. 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) |
|---|---|---|---|
| 05 | 3 | 49.1 (12.8) | 96.6(33.4) |
| 06 | 3 | 80.4(39.9) | 86.4(26.3) |
| 07 | 3 | 58.4(10.7) | 114.4(31.5) |
| VF19 | 3 | 68.9(16.8) | 93.6(17.6) |
| **Park** | **4** | **64.2(13.5)** | **97.8(7.1)** |

## Weather Observations

Onsite weather during the burn fell within the prescribed ranges (Table 1 and 6). Temperature and relative humidity were greater than preferred, however. Winds were southwest, the preferred direction, and had variable speed which averaged the preferred speed. The calculated fine dead fuel moisture was acceptable but greater than preferred and the probability of ignition was in the cool range most of the day. Fine dead fuel moisture began to approach the desired range toward the end of the burn.

**Table 6.** Weather observations.

| | | Temperature | | | | Wind | | Fine dead fuel moisture | Prob. Of Ignition |
|---|---|---|---|---|---|---|---|---|---|
| Time | Location | Dry | Wet | Dew Point | RH | Speed | Direction | (Unshaded) % | % |
| 0830 | HQ, staging | 81 | 73 | 70 | 69 | 5(7) | S | 12 | 20 |
| 0930 | HQ, staging | 86 | 75 | 71 | 60 | 3(7) | SW | 12 | 20 |
| 1000 | HQ, staging | 88 | 75 | 70 | 55 | 3(7) | SW | 10 | 30 |
| 1030 | HQ, staging | 90 | 75 | 69 | 50 | 4(7) | SW | 9 | 40 |
| 1130 | NE corner | 95 | 77 | 70 | 45 | 4(6) | SW | 9 | 40 |
| 1200 | N central line | 95 | 77 | 70 | 45 | 4(7) | SW | 9 | 40 |
| 1230 | N-line 2nd turn | 98 | 78 | 70 | 41 | 4(6) | SW | 7 | 50 |
| 1300 | SW corner | 98 | 78 | 70 | 41 | 3(5) | W/ SW | 7 | 50 |
| 1330 | Carver House | 98 | 78 | 70 | 41 | 2(4) | S/ SW | 7 | 50 |

## Smoke Observations

Smoke did not inhibit activities on the fireline. Although the smoke column was low, it did not affect roads or residential areas because of good dispersal (Table 7).

**Table 7**. Smoke observations.

| Time | Location | Elevation of smoke column | Smoke column direction | Fireline visibility |
|---|---|---|---|---|
| 1145 | Test fire | 20 ft and dispersed | NE | |
| 1205 | N line | 150-200 | | |
| 1215 | S of interior trail | 200 | NE | poor |
| 1240 | S line near pond | 200 then collapsing | | |

## Fire Behavior

Flame height was not recorded. Flame length and flame height may have been similar on level terrain when wind speeds were slow. Fire behavior observations indicated the fire was much less intense than prescribed (Table 2). For example, rates of spread were slower and flame lengths were lower than prescribed (Table 8).

**Table 8**. Fire behavior. 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 | FZD | Fuel model | Intensity (Btu/ft/s) |
|---|---|---|---|---|---|---|---|
| 1145 | E line | Backing | 1.8 | <1 | <1 | 3 | 8.1 |
| 1158 | Interior trail on east | Flank | 2.7 | <1 | <1 | 3 | 8.1 |
| 1200 | N line 80 yd from NE corner | Backing | 1.8 | 1-2 | <1 | 3 | 8.1 |
| 1210 | Near plot 7 | Flank | 1.8 | 1 | 1 | 3 | 8.1 |
| 1230 | Near SE corner | Flank | 5.4 | 2-3 | 2 | 3 | 32.2 |
| 1230 | N line 200 yd | Backing | 1.8 | 2-3 | 1 | 3 | 32.2 |
| 1230 | N line 200 yd | Flank | 2.7 | 2-4 | 1 | 3 | 32.2 |
| 1245 | Near site VF 19 | Backing | - | 1-2 | 2 | 3 | 8.1 |
| 1255 | S line corner/pond | Head | 10.9 | 3-4 | 4 | 3 | 72.5 |
| 1300 | NW line midway | Flank | 5.4 | 10-12 | 3 | | 805.2 |
| 1315 | Carver House | Backing | 3.6 | 2 | 1 | 3 | 32.2 |
| 1315 | W line | Backing | 5.4 | 3-4 | 2 | 3 | 72.5 |
| 1320 | W Line | Head | 13.6 | 10-12 | 4 | 3 | 805.2 |
| 1330 | SW corner | Head | 13.6 | 3-8 | 6 | 3 | 72.5 |

## Fire Severity

Overall fire severity, based on assessment of the standing fuels was light while fire severity, based on the substrate (litter, duff, and soil surface layers), was light to scorched (Table 9). Vegetation with 2 or more inches of stubble remaining post-burn, some plant parts still standing, and litter and duff only blackened to partially consumed indicate these scores. The high fuel moisture levels likely contributed to low severity on the substrate.

**Table 9.** Fire severity values by site (std deviation). N= number of samples. Samples were taken every meter along 10-m transects. Unit B included two transects because of the divided nature of the unit.

| Site | N | Mean severity class - Vegetation | Mean severity class - Substrate |
|---|---|---|---|
| 05 | 32 | 2.8(0.4) | 3.2(0.4) |
| 06 | 32 | 2.8(0.4) | 3.3(0.5) |
| 07 | 32 | 3.1(0.5) | 4.0(0.2) |
| 19 | 32 | 3.3(0.5) | 3.9(0.4) |
| Park | 4 | 3(0.2) | 3.6(0.4) |

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

Fuel reduction was inferred by calculating proportions of data in fire severity classes (see methods). *Substrate* fuels in the burned units were reduced by 21% and v*egetation* (standing) fuels were reduced by about 68%. 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 used only as estimates.

## Burn Extent

The burn units burned completely with only a few isolated locations remaining unburned (Figure 2). These areas were below the threshold size (0.5 ha) for spatial data collection and thus are not represented in the map.

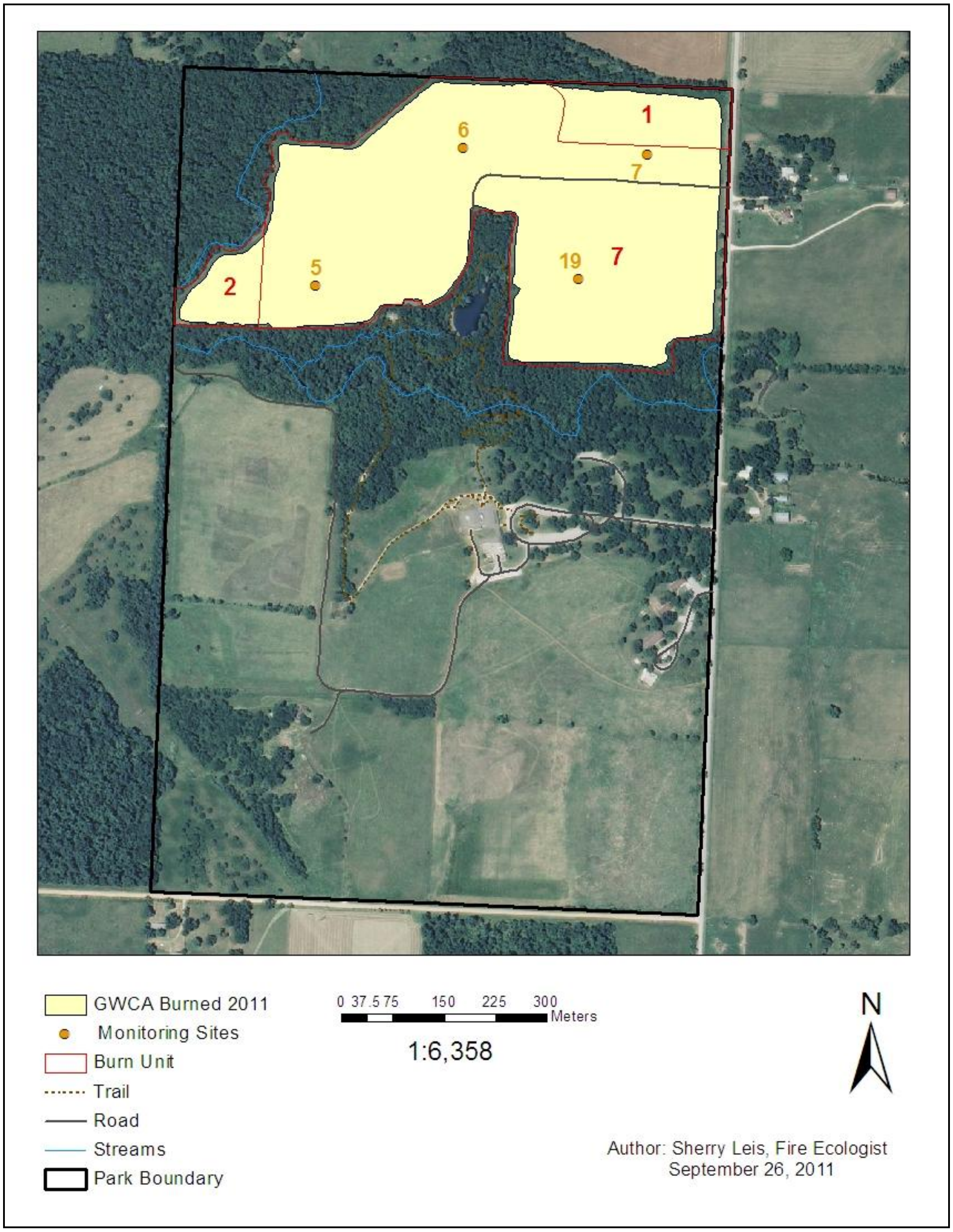


**Figure 3.** GWCA burn units 1, 2, and 7 were burned on 24August2011. Data collected with a Trimble Nomad GPS unit.

## Summary

The prescribed fire on the north units of the prairie (1, 2, and 7) at GWCA was successful in that firefighter and public safety were preserved. The operation was challenging because of the high fuel moisture and hot air temperatures of the day. It is not possible to assess the resource objectives in this report, however the HTLN vegetation monitoring and invasive species programs will address native plant and exotic plant abundances during regular monitoring. Additionally, the fire ecology program will assess woody shrubs and trees in the prairie by comparing a 2011 pre-burn assessment to an upcoming post-burn assessment in 2012.

Prescribed fire objectives focused on fuel reduction. The goal of reducing 1- and 10-hour fuels by 20-50% was met for substrate fuels (21%) and surpassed for standing fuels (68%). These reduction percentages are estimates based on the severity data and should be applied with caution. No 100 or 1000-hr fuels were observed in the monitoring sites.

Based on our post-burn mapping, the objective to blacken 75-95% of the burn units was also surpassed. Furthermore, fire intensity did vary throughout the unit, with the western part of the prairie receiving greater observed intensities and increased fire behavior.

Light fire severity likely resulted from a combination of high litter moisture and green standing vegetation. The moisture of the litter layer, the primary fire carrier, likely played an important role. However, it is possible that fire behavior was also limited by mowing that took place during the previous year. We observed that the litter layer was compacted in the eastern part of unit 7 because of the mowing treatments to reduce invasive plants. Compacted litter limits oxygen availability within the fuel bed and can inhibit combustion and fire spread.

Even though fire severity was light across the prairie, the burn was valuable because fuel loads were reduced and increased the potential for stimulation of nutrient cycling and germination of desirable plants.

## Literature Cited

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.

Mier, A. and S. Morey. 2010. George Washington Carver National Monument prescribed fire plan. National Park Service.

National Wildland Coordinating Group. 2006. NWCG Fireline Handbook, Appendix B Fire Behavior. PMS 410-2, NFES 2165. Boise, Idaho.

# Appendix-Sample Site Photographs

**Figure 4.** Pre-burn site 5 AS-AF.

**Figure 5.** Post-burn site 5 AS-AF.

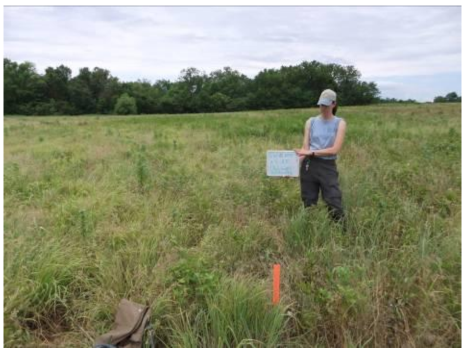

**Figure 6.** Pre-Burn virtual site 19 AS-AF.

**Figure 7.** Post-burn virtual site 19 AS-AF.

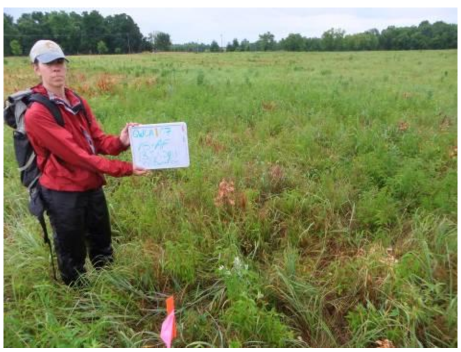

**Figure 8.** Pre-burn site 7 AS-AF.

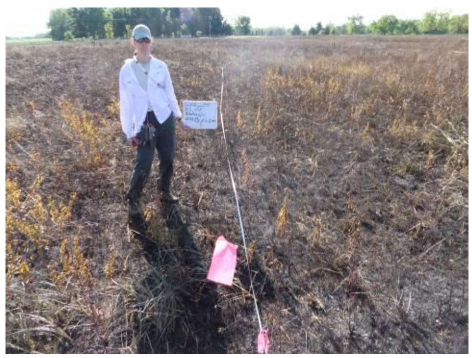

**Figure 9.** Post-burn site 7 AS-AF

**Figure 10.** Southwest burn line near Carver House.

**Figure 11.** Burning around demonstration garden.