National Park Service
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Natural Resource Stewardship and Science

# Prescribed Fire Monitoring Report

*Homestead National Monument of America, 2014 (NFPORS ID3325472)*

Natural Resource Data Series NPS/HOME/NRDS—2015/745

**ON THE COVER**
Post-burn image of a thicket at Homestead National Monument of America.
Photograph by:  Sherry Leis, HTLN files.

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Sherry A. Leis

Missouri State University
901 S National Avenue
Springfield, MO 65897

January 2015

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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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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Please cite this publication as:

Leis, S. A. 2015. Prescribed fire monitoring report: Homestead National Monument of America, 2014 (NFPORS ID3325472). Natural Resource Data Series NPS/HOME/NRDS—2015/745. National Park Service, Fort Collins, Colorado.

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## Acknowledgments

Thanks to Adam Throckmorton for field support. Field observations on burn day from Cody Wienk and Scott Beacham were helpful in filling in some gaps in the report.

## List of Acronyms

| Term | Definition |
| --- | --- |
| ATV | All-terrain vehicle |
| HOME | Homestead National Monument of America |
| HTLN | Heartland Inventory and Monitoring Network |
| NPS | National Park Service |
| RH | Relative humidity |
| Stdev | Standard deviation |
| UTV | Universal terrain vehicle |

# Introduction

The purpose of this fire report is to document the prescribed fire operation that took place at Homestead National Monument of America (HOME) on April 17, 2014. Additionally, I present monitoring data and onsite observations which describe the results of the fire and put this fire in context of others at HOME that have been monitored in the recent past. Our goal in monitoring and reporting prescribed fire operations and fire effects is to provide data to managers and operations staff so that management decisions can be made on sound science. We also provide this information so that fire operations remain safe and efficient while achieving management goals and objectives.

The fire ecologist was unable to be onsite at the time of the burn. Burn day operations and observations were provided by operations staff through the incident action plan, photographs, and progression maps (Figure 1). Post-burn monitoring of fire severity and photo points was conducted by the HTLN fire ecology team.

### Burn Unit Measurements

**Date:** 2014
**Units:** 1, 2, 5 last burned in 2010, 2009, and 2007, respectively.
**Size:** Planned acres = 64.5, actual acres burned = 61.0
**Vegetation type:** Tallgrass prairie (fuel model 3)
**Personnel:**

- Burn Boss: Scott Beacham, Burn Boss Trainee: Rick Jones
- West Side: Line Boss: Cody Wienk
  Engine: Bryce Huss, Jerimaiah Yurka, UTV: Greg Ficker, Ignition: Jim McMahill, Drew Hughes, Holding: Paul Mancuso
- East Side: Line Boss: Adam Roger
  UTV: Steven Bowsher, Mat Gillstorm, James Simon, Ignition: Jesse Bolli,
  Holding: Robbie Meyer.

**Objectives** The summary section will address how well the burn met prescribed fire objectives. A new objectives were drafted in 2013, but the plan has not yet been updated. The objectives shown here are from the 2007 plan (Beacham 2007).

#### *Prescribed fire objectives:*

1. Ensure that firefighter and public safety remain highest priority.
2. Keep fire inside boundaries of proposed prescribed fire units.
3. Ensure personnel are wearing all required PPE while on the burn site.
4. Ensure public safety by maintaining appropriate road safety and warning signs, and preventing smoke emissions from significantly impacting highway visibility throughout the burn.

#### *Resource objectives:*

1. To manage vegetation communities and to achieve resource management objectives to preserve the natural resources associated with the Homestead Act of 1862.

2. Reduce shrub and small tree encroachment by 0-25%.
3. Stress cool season non-native grass species.
4. Reduce 1-hour grass litter by $\geq$ 70% immediate post-burn.

**Table 1**. Selected environmental prescription elements for fuel model 3 for Homestead National Monument of America. The full prescription can be found in the prescribed fire plan (Beacham 2007).

| Variables | Preferred State |
|---|---|
| Relative Humidity | 30-80 % |
| Wind direction | All winds except S to SW |
| Wind Speed (midflame) | 1-8 mph |
| Dead Fuel moisture (%) 1-hour | ≥7 % |
| Rate of spread (ch/h) | 199 |
| Flame length (ft) | 16.7 |
| Fireline intensity (Btu/ft/s) | 2593 |

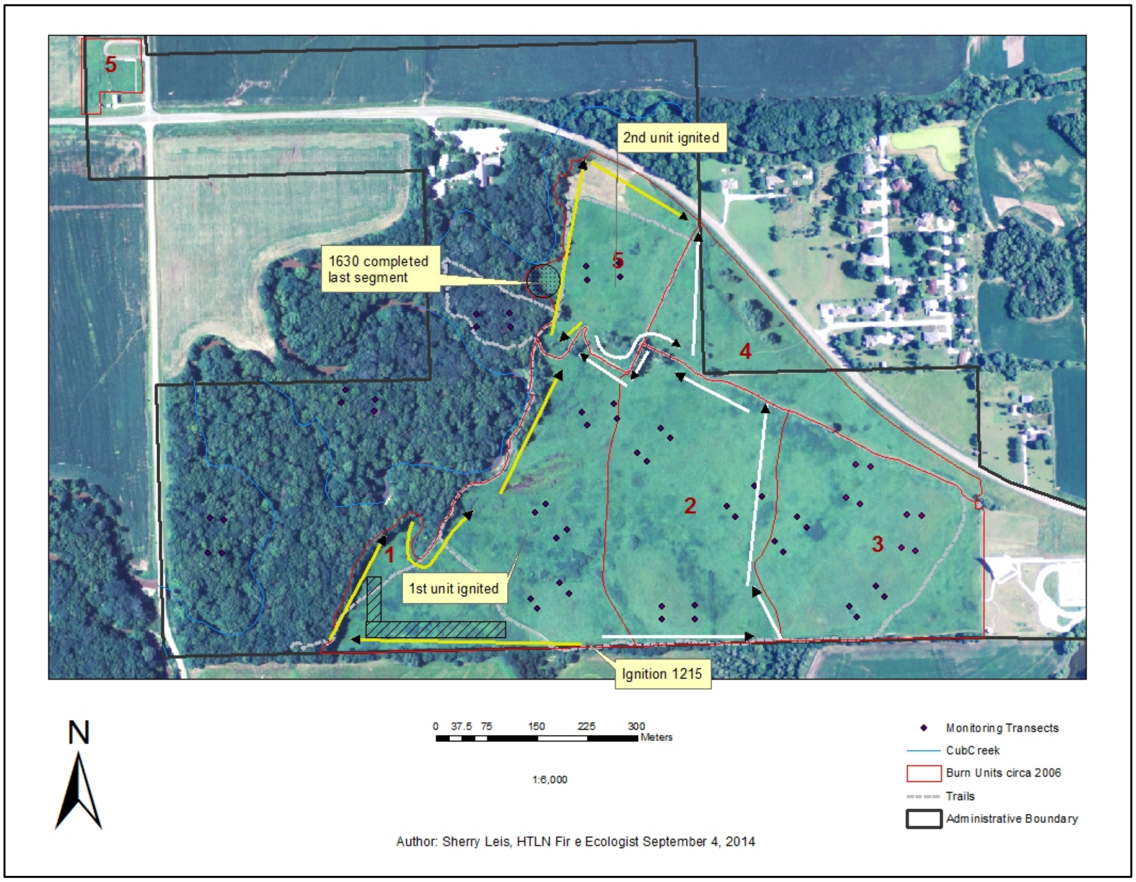


**Figure 1.** Map of operational progression through burn units at Homestead National Monument of America on April 17, 2014. Burn units labeled in red were burned in the following order 1 and 2 together, 3, and then the western extension of 5. Arrow colors indicate the direction of two crews progressing in a ring fire technique through each grouping of burn units. Time (24 hrs) of arrival are shown in the callout boxes. Hatch area indicates stripping ignition techniques and stippled circle was completed last.

## Methods

This report will describe the fuel and environmental conditions present for the prescribed fire on April 17, 2014 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). Monitoring sites were randomly distributed in burn units so that each unit could be analyzed individually (Figure 1). However, one site in unit 1 was mistakenly omitted during sampling. Monitoring was conducted only within the current year's burn units (1, 2, 3, 5).

Pre-burn monitoring of fuel loads, fuel moisture, and soil moisture was not completed due to scheduling constraints. Burn day weather onsite (including temperature, humidity, wind, calculated fuel moisture and probability of ignition) was collected by Cody Wienk. NOAA data from the Beatrice Municipal Airport weather station were used for additional hourly reports, precipitation summaries, and to compare to 30 year normals (NOAA 2014).

Post-burn fire severity and photopoints were collected on April 25, 2014. 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 HTLN staff. 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 and 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.

Statistical analyses were conducted using mean values for monitoring sites. Kruskal Wallis tests with multiple comparisons were used to test for differences in fire severity for fires in 2010-2014 (Daniel 1990). SPSS statistical software (Version 20) was used for all analyses (IBM 2011) and an experiment-wise error rate of 0.10 was applied.

# Results

## Weather Observations

Weather during the burn met the prescription with one exception (wind direction briefly came from the SW; Table 1, 2). Only two data points for weather were obtained onsite (Table 2). Hourly weather data was obtained online for the Beatrice weather station at the Municipal airport for this report (NOAA 2014) and fine dead fuel moisture and probability of ignition were then calculated. Winds were variable through the burn period with one reading from the Beatrice weather station from the SW. Winds were only briefly from that direction. Conditions were dry with total precipitation for March and April (4.7 cm, 1.8 in.) being well below normal (12.7 cm, 5.0 in.; NOAA 2014). Moreover, only 1.2 inches (3.1 cm) of precipitation were recorded between January 1 and burn day (NOAA 2014).

**Table 2.** Weather observations collected during the prescribed fire at Homestead National Monument of America on April 17, 2014. NOAA data were obtained online and hourly values during the burn period are shown here. Windspeed values in (mph) are maximum gust speeds.

| | | Temperature | | | | Wind | | Fine dead fuel moisture | Prob. Of Ignition |
|---|---|---|---|---|---|---|---|---|---|
| Time | Source | Dry | Wet | Dew Point | RH | Speed (mph) | Direction | (Unshaded) % | % |
| 1030 | On site | 41 | 35 | 27 | 56 | 1-3 | N | 10 | 30 |
| 1245 | On site | 46 | 40 | 32 | 59 | 1-4(5) | NNW | 9 | 30 |
| 1215 | NOAA | 47 | 39 | 27 | 46 | 8 | NW | 8 | 40 |
| 1315 | NOAA | 50 | 41 | 28 | 43 | 5 | E | 7 | 40 |
| 1415 | NOAA | 52 | 41 | 27 | 38 | 3 | SW | 7 | 40 |
| 1515 | NOAA | 55 | 43 | 26 | 33 | 7 | NE | 6 | 50 |
| 1615 | NOAA | 56 | 43 | 27 | 33 | 0 | N | 6 | 50 |

## Smoke Observations

Operations staff related that smoke dispersal during the operation was excellent (Figure 2, 14, 15). No measurements were taken of the smoke, but it did not impede operations or public safety.

**Figure 2.** The smoke column during the 2014 prescribed fire at Homestead Monument of America dispersed vertically. Photo by P. Mancuso.

## Fire Behavior

Fire behavior was active during the operation including at least one fire whirl observed by operations staff (Figure 3). No measurements of fire behavior were collected.

**Figure 3.** Burn day operations fire whirl obscured by the smoke column. Fire whirls indicate intense fire behavior. S. Beacham photo.

## Fire Severity

Fire severity and fire intensity are two parameters that contribute to plant mortality. It is often assumed that greater severity and intensity will lead to greater mortality of target species. Fire severity measures provide an indication of the result of the fire by assessing the remaining fuels, stratified by fuel layer (vegetation and substrate). Our assessment focused on herbaceous fuels, however, heavy fuels (100- and 1000-hr), were observed to have been largely consumed during the burn (Figure 4). This is somewhat unusual for a small prairie burn.

**Figure 4.** Burned out stumps indicate dry heavy fuels and greater fire severity.

Fire severity classes used for monitoring were the following: 0 = NA, 1 = heavy, 2 = moderate, 3= light, 4 = scorched, 5 = unburned. Fire severity in 2014 was moderate for standing fuels (park mean = 1.7 ± 0.3 stdev) with site means ranging from 1.2 (heavy) -1.9 (moderate). Substrate fuels (i.e., litter, duff, and soil surface layers) mean fire severity was light (park mean = 2.9 ± 0.2 stdev) with site means ranging from 2.8 – 3.3 (Figure 5). Moderate vegetation 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.

We compared fire severity for the 2014 burn with severity resulting from recent burns in 2010, and 2011 to better understand how differences in management, weather, and fire operations may have contributed to fire effects over time. Substrate and vegetation severity differed across burn years (chi-square = 10.07, df = 2, P = 0.01 for substrate; chi-square = 9.48, df = 2, P = 0.01 for vegetation). Substrate was more severely burned in 2011 than in 2010 or 2014, while vegetation was more severely burned in 2014 than either 2010 or 2011 (Figure 5).

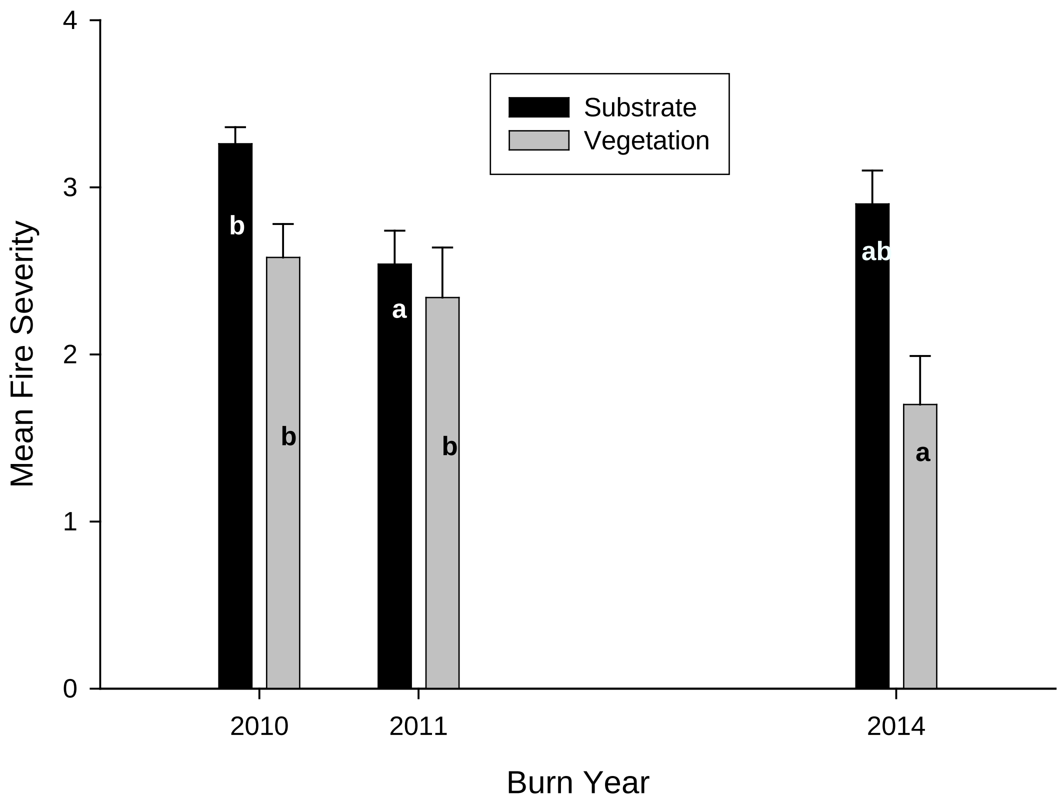


**Figure 5.** Comparison of fire mean fire severity for recent prescribed fires at Homestead National Monument of America. Error bars are standard deviation. Fire severity classes are the following: 0 = N/A, 1 = heavy, 2 = moderate, 3= light, 4 = scorched, 5 = unburned. Substrate and vegetation severity were assessed separately. Years that were significantly different from each other are indicated by letters.

***Fuel reduction***

Vegetation (standing) fuels were reduced by about 99%. However, the prescribed fire objective of reducing grass litter ≥ 70% was technically not met because substrate fuels were reduced by about 55%. However, this may be a semantics difference that was addressed in a revision to the prescribed fire objectives (pending updating the plan). Fuel reduction elements have varied from burn to burn (Figure 6), but vegetation fuels have been reduced by > 70% each year and 2014 saw the greatest reduction. 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.

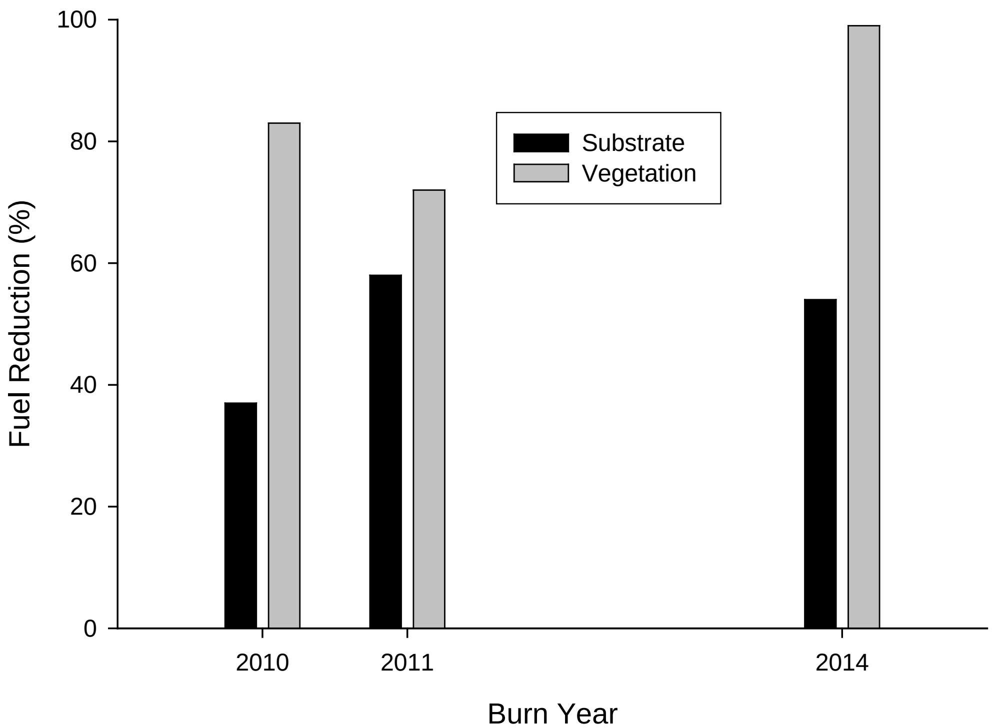


**Figure 6.** Estimates for fuels reduction for recent prescribed fires at Homestead National Monument of America. Estimates are based on fire severity data and should be used cautiously.

## Burn Extent

The burn units burned completely with only a few isolated locations remaining unburned (Figure 7). 94.6% of the target units was burned. However, the burn lines were not mowed exactly with the boundaries of the burn units. Completeness calculated based on the mowed lines rather than burn units was 99.8%. The 2014 burn was slightly more complete than other recently monitored burns (Figure 8).

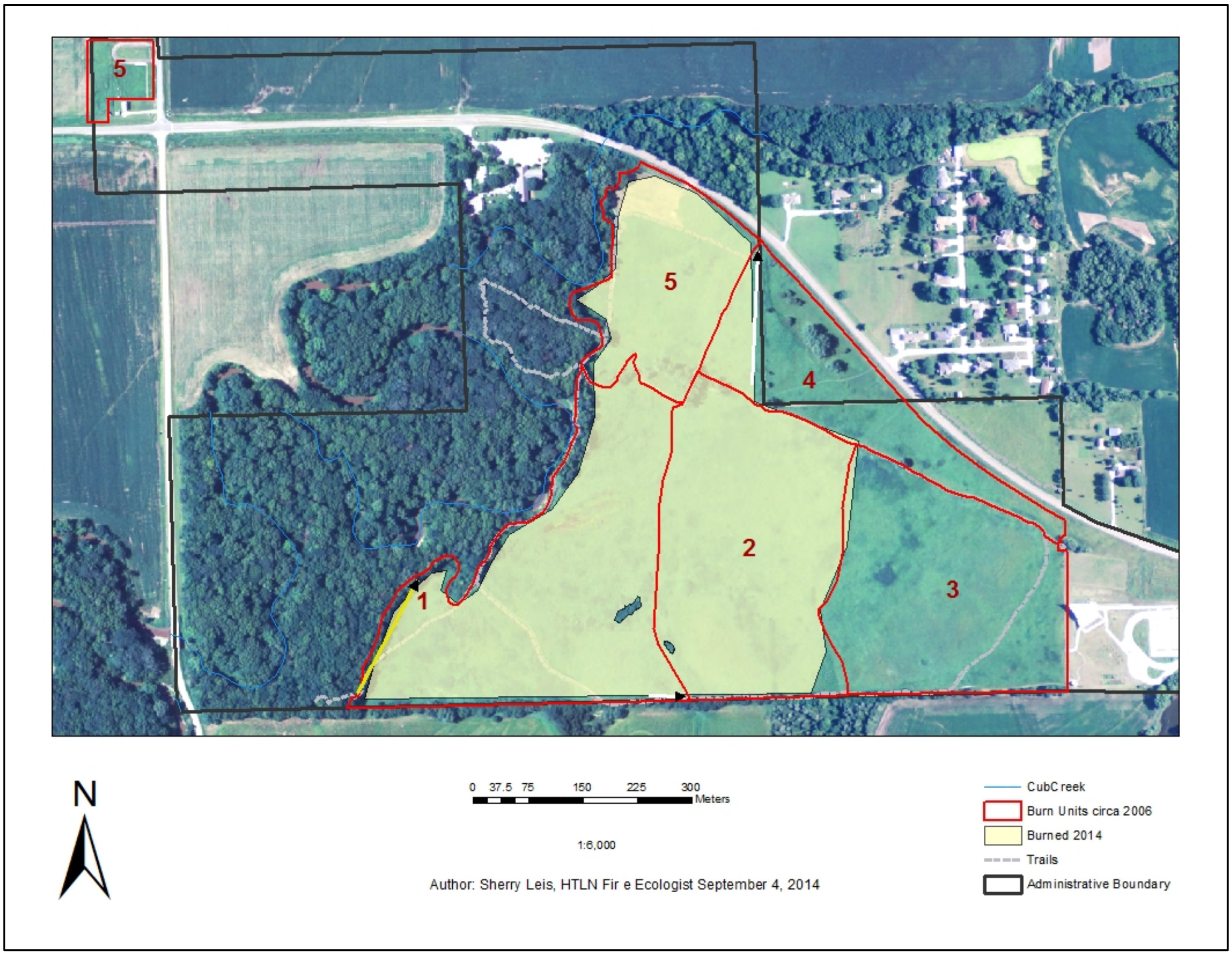


**Figure 7.** Area burned April 17, 2014 and at Homestead National Monument of America. Data were collected with a Trimble Nomad GPS unit.

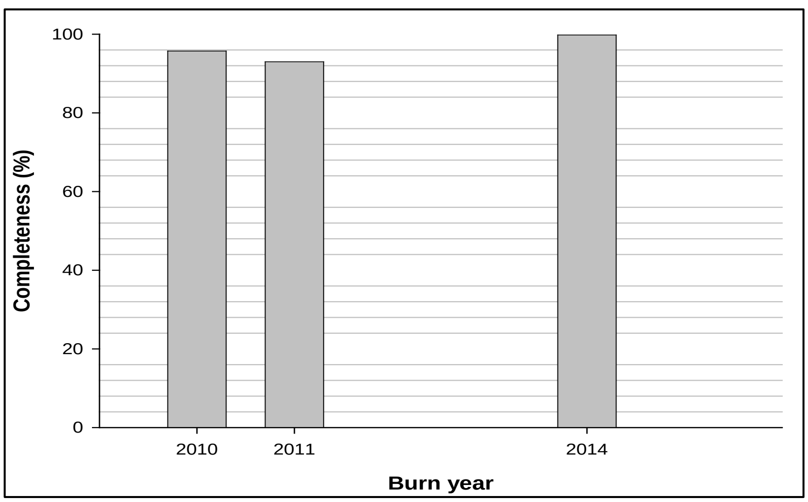


**Figure 8**. Burn completeness was greater in 2014 than in 2010 or 2011 at Homestead National Monument of America.

## 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. This report also attempts to put the monitoring data in context of previous burns. Adaptive management can then be implemented using sound data and analysis (National Park Service 2008). Long-term fire-centric analysis will later look for trends and relationships of fire to vegetation goals.

The 2014 prescribed fire at HOME was successful in that firefighter and public safety were preserved. The fire breaks were mowed generally congruent with burn unit boundaries, but did deviate slightly especially in the northeast part of unit 5. The fire stayed within the prepared firebreaks. Weather along with ignition techniques allowed for good smoke dispersal and little impact on visitors or motorists.

The prairie was more completely burned in 2014 (Leis and Bolli 2010, Leis and Kopek 2011). The fire management plan encourages a mosaic of burn severities, but it is commonly thought that woody plant encroachment reduction goals might be better met with more complete higher intensity fire (Leis 2008). There is still much research to be done in this area of fire ecology. Unfortunately, we were unable to collect fire behavior data on this fire. Fire behavior data including flame heights and fire intensity can be helpful in understanding fire effects. Ideally, sensitive meristems of target plants would receive adequate heat over time to cause mortality. Post-fire moisture and plant physical conditions also contribute to post-fire mortality or recovery (Leis 2008).

The resource goal of reducing woody plant encroachment must be evaluated post-burn. The most recent HTLN report (Haack 2010) noted a substantial increase in shrubs. Since that time, several cutting, mowing, herbicide, and spray treatments have taken place. The revised goal for woody plant encroachement submitted to NPS fire for revision in the next burn plan is: By 2015, reduce shrub and small tree cover in the prairie to ≤ 15 acres (a 53% reduction from 2010) using a combination of fire, mechanical, and herbicide treatments.

Cool season invasive grasses have also been a concern for the park. A revised goal was written to address this more quantitatively than the current one of stressing the cool season species. The new goal was written as:

> maintain smooth brome (*Bromus inermis*) and Kentucky Bluegrass (*Poa pratensis*) within or below the cover class represented by the mean value from 2009 vegetation monitoring (class 1 and 2, respectively). If mean cover increases to the next cover class (class 2 and 3 respectively) by the next monitoring period, vegetation management, including fire and other treatments, will be assessed and adaptive management applied.

The burn occurred earlier than target dates to maximize stress on the cool season plants. We do not yet know whether that objective was met with this fire, but the target cool season species were on the increase prior to the burn (HTLN unpublished 2013 data).

Fire severity of the vegetation strata was greatest in 2014 and both substrate and vegetation severity varied across the park. 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.

The goal of reducing 1-hour grass litter could not be assessed because the comparison level is not stated. Additionally, it is unclear as to whether the word litter actually referred to the fuel matrix and not just the substrate layer. The substrate layer containing litter was only reduced by about 55%, but the standing fuels were more substantially reduced (99%). A new goal to clarify this element has been drafted to read:

> Reduce fuel load (above ground biomass including litter), in target burn units, immediately post-burn by at least 70% of preburn levels as estimated by fire severity measurements in categories 1, 2, and 3.

It is hoped that greater fire intensity will provide greater control of invasive species (e.g. sumac, dogwood, smooth brome) than a less intense fire. The fire intensity values are an indication of the energy produced (heat over time) in a given location (unavailable for this fire). Fire severity is a manifestation of the fire's ability to consume fuel components. Average vegetation fire severity was moderate. Although we were unable to collect fire intensity for this fire, field observations support the analysis in this report that this burn was more complete and burned the vegetation more thoroughly than previously monitored burns. Dry conditions reflected in low fine dead fuel moistures and below normal precipitation contributed to effective fuel reduction. Moreover, efforts to cut and herbicide shrub mottes within the prairie allowed for fine fuels to be available for burning leading to a more complete burn than in the recent past.

Although not all the objectives stated in the prescribed fire plan (Beacham 2007) can be evaluated with the data presented in this report, additional monitoring of plant communities by HTLN ecologists will address the status and trends of plant communities at HOME (e.g., number of native and exotic species, coverage of woody plant encroachment).

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# Appendix A

**Figure 9.** Post-burn site 2 Transect AS-AF.

**Figure 10.** Post-burn site 2 transect BS-BF.

**Figure 11.** Post-burn site 77 transect AS-AF.

**Figure 12.** Post-burn site 77 transect BS-BF.

**Figure 13.** Unburned thicket. Very little area was left unburned.

**Figure 14.** Smoke dispersal during the burn operation. C. Wienk Photo.

**Figure 15.** Active fire behavior and excellent smoke dispersal during the burn operation. P. Mancuso Photo.

NPS 368/127603, January 2015

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**Natural Resource Stewardship and Science**
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov