

Homestead National Monument of America-2016 Prescribed Fire Event in Collaboration with the University of Nebraska – Lincoln’s (UNL), Nebraska Intelligent Mobile Unmanned Systems (NIMBUS) Laboratory.

#### **Park Information:**

Homestead National Monument of America (Homestead) located in southeast Nebraska, 45 miles south of Lincoln, celebrated its 80<sup>th</sup> Anniversary March 19, 2016. This site commemorates the Homestead Act of 1862 and the changes this law brought not only to the United States but to the World. Historians consistently rank the Homestead Act of 1862 as one of the Nation’s most significant pieces of legislation. This law had far reaching impacts with land use, immigration, industry, agriculture and Native People. The Homestead Act was signed into law by President Abraham Lincoln in 1862. The law was in effect until 1976 in the lower 48 states and 1986 in Alaska. Today, there are an estimated 93 million Homestead Descendants.

#### **Fire Program History at Homestead:**

Homestead has a very active prescribed fire program that dates back to the 1970’s; since the early 1990’s the monument has used prescribed fire on almost a yearly basis to enhance and manage the oldest restored prairie in the National Park Service (NPS), the second oldest restored prairie in the United States.

The resource goals for burning within the restored prairie are to reduce shrub and small tree cover, to combat invasive cool season grasses such as smooth brome and Kentucky bluegrass, to reduce dead plant material and promote diversity in the prairie. Additionally, the goal for this prescribed fire was to conduct a live test of the small unmanned aircraft system (sUAS) consistent with the intent of 2015 unmanned aircraft system (UAS) Technology Overview approved by then NPS Associate Director of Visitor Resource Protection, Cam Sholly; Department of Interior Deputy Assistant Secretary, Kim Thorsen; Office of Aviation Services, Director Mark Bathrick and other National Interagency Fire Center Bureaus.

#### **Use of small Unmanned Aircraft Systems (sUAS) During Homestead Prescribed Fire:**

Planning for the 2016 prescribed fire began in the fall of 2015 shortly after the October 16 prescribed fire. The decision was made to burn the 26 acre unit in the southwest portion of the prairie during the spring of 2016. On October 30, 2015, an article appeared in the University of Nebraska-Lincoln’s *UNL Today* web publication titled “Fire-starting drone that could aid in conservation, fire prevention”.

Discussions then began between Homestead and the Midwest Region Fire and Aviation Program regarding the possibility of testing the sUAS at Homestead.

In the fall of 2015, members of the Midwest Region Fire and Aviation Management staff arranged for a meeting with the UNL Computer Science and Engineering Department to discuss the possible use of the sUAS at Homestead and get a demonstration of the capabilities of the aircraft. During that demonstration, which took place within the NIMBUS lab, the UNL staff was able to demonstrate the aerial ignition capability of the sUAS using a special modified plastic sphere dispensing (PSD) aerial ignition system. The Midwest Regional fire management staff saw the potential future benefits of an unmanned aerial ignition platform to improve firefighter safety. They invited the UNL group to utilize their sUAS aerial ignition platform (plastic sphere dispensing system) at the Homestead National Monument prescribed burn. This burn was an ideal selection given the proximity to Lincoln, NE as well as the unit being small enough for the line of sight constraints that the use of the sUAS required.

Through extensive research, commitment, conference calls and site visits, Homestead, with the help of the Midwest Regional Office (MWRO) staff and James Traub the NPS UAS Specialist in collaboration with UNL were able to obtain the needed clearances from NPS Associate Director for Visitor and Resource Protection (AD-VRP) and the Federal Aviation Administration (FAA) to allow the UNL-NIMBUS to test the fire starting sUAS at Homestead.

Key staff that had major roles in preparing the compliance and permitting documentation were:

- Mark Engler, Superintendent, Homestead National Monument of America
- Jesse Bolli, Resource Management Specialist, Homestead National Monument of America
- David Niemi, (Acting)Chief of Fire and Aviation Management, NPS Midwest Region
- Scott Beacham, Regional Fuels Management Specialist, NPS Midwest Region
- Michael Johnson, Fire Communication and Education Specialist (Acting) and Regional Public Affairs Officer, NPS Midwest Regional
- Jim Traub, Contractor Pilot, Fleet Aircraft and UAS Specialist, NPS Aviation Branch, National Interagency Fire Center
- Dr. Sebastian Elbaum, Professor in the Computer Science and Engineering Department, the University of Nebraska-Lincoln
- Dr. Carrick Detweiler, Assistant Professor Computer Science and Engineering, University of Nebraska-Lincoln
- Dr. Dirac Twidwell, Assistant Professor, Rangeland Ecologist Department of Agronomy and Horticulture University of Nebraska-Lincoln
- Dr. Craig Allen, Leader of the U.S. Geological Survey - Nebraska Cooperative Fish and Wildlife Unit, University of Nebraska-Lincoln

Approval was received on March 28, 2016 from the Associate Director of Visitor and Resource Protection for the NPS.

### **Site Preparation**

On March 22, 2016 to prepare Unit 1, the 26-acre tallgrass prairie unit located in the southwest corner of the monument, fire control lines triple in the normal width were put in place as a precautionary

measure. A local hay harvesting contractor, Steve Wright, windrowed and baled the vegetation from the fire lines. On March 23, 2016 UNL, MWRO Fire Staff and Homestead Staff met at the park to review the burn unit. Several conference calls took place with UNL Researchers, NPS Fire Staff, Department of Interior Staff and Homestead Employees. With the approval, regional and park staff began monitoring the weather forecast, looking specifically for a north wind that was less than 10 miles per hour to complete the prescribed fire. Watching the 10-day forecast, the latter part of the week of April 17<sup>th</sup> was identified as a possibility; however rain was predicted for all week. On the 17<sup>th</sup> the park received 0.75", on the 19<sup>th</sup>, the park received another 0.75" and on the 20<sup>th</sup> it received 0.30", for a grand total of 1.80 inches of rain in the five days leading up to the fire. On Thursday, April 21 partly cloudy skies and wind were predicted and there was mostly cloudy conditions all day; however there was no new rain, a semi good drying day.

Shortly after noon on the 21<sup>st</sup> Burn Boss, Scott Beacham and the Fire Information Officer, Michael Johnson arrived at Homestead from the Midwest Regional Office to get ready for the fire and look over the unit. By walking the perimeter of the unit it was determined that the tough prairie sod would support the utility task vehicles (UTV's). The UTV's are necessary because they carry water tanks used as spray units to ensure that the fire does not cross the control line. During the walk the wet areas that would need to be avoided with the UTV's were identified.

#### **The Prescribed Fire Event:**

Friday, April 22, 2016 the day of the prescribed fire and the test of the sUAS had arrived. Winds were as predicted, light from the north and not a cloud in the sky, a perfect day to burn. Staff was onsite at 7 a.m. setting up and getting ready for the prescribed fire. A local burn permit from Gage County, Nebraska was obtained to ensure compliance with local ordinances.

Firefighters assisting with the prescribed fire were: two from Homestead National Monument of America, three from NPS Midwest Regional Office, seven from NPS Black Hills Wildland Fire Module, four from Wind Cave National Park, five from Bureau of Indian Affairs-Horton Agency, two from Beatrice Rural Volunteer Fire Department, and one from Fairbury Rural Fire Department. Fire ecologist from the NPS Heartland and Inventory Monitoring Program, Sherry Leis, was on-site and provided weather updates throughout the fire event.

By 10:30 a.m., everything was ready and it was time for the briefing, which lasted about an hour. By 12:15 p.m., everything and everyone was in place and the test fire was started. The firefighters were split into two groups; one igniting and holding the east flank and the other igniting and holding the west flank. After the ignitors had created a sufficient black line on the south, downwind side of the burn, they slowly started working to the north thus allowing the university time to test their sUAS to complete the interior ignition of the unit. The prescribed fire went as planned and ignition was completed when the groups from the east flank and west flank met on the north end at 2:00 p.m. A debriefing with the firefighters and the university personnel was then held.

No issues or accidents were identified during the debriefing; this was due to good planning, experience level of the firefighters, many of whom had worked together on the October prescribed fire at the monument, proper preparation work done to create the fire lines and the perfect weather, including the recent moisture.

### **sUAS Results:**

The researchers from UNL called their work successful. The lead researcher, Sebastian Elbaum, shared; the sUAS "worked great." He further stated, "things they wanted to verify with the technology, were verified and they came away from the test with a greater understanding of ways the sUAS technology can be improved." In the closeout briefing, the need for the sUAS to work quicker and in a straight line in delivering the fire ignition balls was discussed.

The following is a statement from Sebastian Elbaum that speaks to the test:

Key researchers from UNL's NIMBUS Laboratory who developed the sUAS are Sebastian Elbaum and Carrick Detweiler. The goals of the NIMBUS Lab from the University of Nebraska-Lincoln were to demonstrate the potential of the sUAS based ignition technology, to assess its maturity, and to collect further data for the students performing research that can help to further evolve the technology.

The demonstration at Homestead went without incident and achieved all its goals. The NIMBUS sUAS prototype performed five flights of approximately 10 minutes each, along programmed trajectories specified by the burn-boss and that were often updated as the context changed, and dropping almost 100 ignition spheres in targeted locations up to 600 feet away from the launch site. Field observations and data collected by our team of faculty and four students confirmed that the sUAS-based ignitions were successful, followed the specified patterns, and overall performed as expected.

The sUAS had no trouble navigating and operating across ignited and not-ignited areas, flying between 45ft and 75ft AGL, with winds averaging 5 knots. The sphere delivery occurred at the specified temporal intervals and within yards of the specified targets.

The sUAS also carried additional sensors and a camera to enable further data collection, which reduce the payload capacity and flying time, and required additional preparation time. However, the trove of data collected is being analyzed, together with feedback obtained directly through the interactions with the fire personnel on the ground, which will help to drive the next step forward with the technology.

The researchers in the NIMBUS Lab look forward to any other feedback from NPS, DOI, or related agencies on aspects to be considered to evolve the technology, and also on suggestions on how to further support and fund the technology development

### **Media:**

Media covering the event included eleven different organizations including: the Associated Press, KOLN-TV (CBS Lincoln), KETV (ABC Omaha), KLKN (ABC Lincoln), WOWT (NBC Omaha), Nebraska Educational

Television (PBS Lincoln), Wildland Fire Today, KWBE Radio (Network Nebraska, Beatrice), Lincoln Journal Star, Omaha World-Herald, Beatrice Daily Sun and University of Nebraska-Lincoln Communications.

**Conclusion:**

The testing of the sUAS was a great success because of the support from all levels of the National Park Service, the Department of Interior, the hard work that was completed by the University of Nebraska NIMBUS Lab, NPS Midwest Region Fire and Aviation Program and the entire staff of Homestead National Monument of America.