Joint Fire Science Program

Fire Science Brief

RESEARCH SUPPORTING SOUND DECISIONS

Simulated archeological materials were placed on study plots during prescribed fire on NPS properties to evaluate potential effects of the fire on artifacts.

Can Archeology Survive a Fire?

Summary

Most public lands include not only natural resource values, but also significant cultural resources from both historic and prehistoric occupation. In some cases, the cultural resources are the reason for establishment of a park or monument. Responsibilities of the managers of these lands include protecting these cultural resources and balancing their protection with protection of the natural resources. This is essential to having a good understanding of the potential effect of fire—whether a prescribed fire or a wildfire—on the cultural resources.

A recent scientific project funded by the Joint Fire Science Program studied the potential impact of wildland fire on near-surface archeological resources at six diverse sites within the Midwest Region of the National Park Service (NPS). Information was collected on fire conditions in prescribed fires on these sites. Data was collected on the impacts of fire on multiple classes of archeological materials routinely observed on sites within this region. Research encompassed different regional environments and different resource types. It is believed that by having this information, park managers will be able to more effectively balance the needs of natural and archeological resources.

Key Findings

- Fuel and fire conditions in the Midwest are different from those in the West. For this reason, potential impacts on archeological resources require separate study.
- Both the intensity and the duration of fires have an influence on potential damage to archeological materials.
- Using research plots on the sites of prescribed fires on Midwest Region park properties, researchers were able to establish baseline data on anticipated types of damage to archeological materials.
- Many archeological materials—stone, glass, bone, many metals—exposed to prescribed fire received only minimal damage, and could readily be cleaned to remove surface discoloration.
- Certain other materials, including wood, leather, porous ceramics, and bone, were sometimes more permanently discolored or received other damage including charring, cracking, spalling, and actual destruction.
- Evaluation of sites of archeological interest before prescribed fires should consider both the fuel levels and the types of archeological materials that may be exposed to fire.

Fire and archeology

In recent decades, investigators have shown that wildland fire can sometimes have significant impact on archeological records. Under some circumstances, fire can lead to the loss of useful information about past cultural groups. Impacts can range from negligible to severe, depending on the type of fire and the type of archeological asset. However, most previous studies have focused on fire conditions and archeological resources on properties in the Intermountain West and the Southwest. Here, wildland fires can occur on an annual basis. Midwest Region sites have lacked specific information using local fire information and possible impacts to resources.

The NPS Midwest Region includes the states of Arkansas, Kansas, Nebraska, South Dakota, North Dakota, Missouri, Iowa, Minnesota, Illinois, Wisconsin, Indiana, Michigan and Ohio. A wide range of NPS properties include Civil War battlefield sites, Native American villaqes, early European settlements and a wide range of natural resource and recreation areas that also include important cultural and archeological resources.

Because of the size of this region, no single approach to the fire-archeology interface is practical. Yet park managers are forced to make decisions that balance the use of fire and the preservation of archeological resources without the benefit of regional scientific data. To relieve this situation, a region-wide multi-park, multi-environmental experimental project was developed. The goal was to provide relevant, scientific data for fire management over a wide range of parks in the region.

A pilot study had been conducted by the Midwest Archeological Center (MWAC) in 2005 at Knife River Indian Villages National Historic Site in North Dakota. The study was conducted to evaluate the effect of prescribed fires within archeological sites. Multiple burning techniques (head, backing and flanking fires) were evaluated to determine types of burns and techniques with the lowest potential to impact surface archeological resources. The study filled knowledge gaps regarding fire characteristics and impacts on local archeological resources. As a result of this project, this park now has information that will allow it to move forward with a native prairie restoration program that addresses issues of archeological resource preservation.

Many National Park Service properties feature a complex combination of natural resource and cultural elements. The challenge for managers is to use prescribed fire appropriately to manage fuel levels and protect resources. Pictured above is the Great Bear Mound Group at Effigy Mounds National Monument within the hardwood forest of northeast Iowa. Credit: Jay Sturdevant.

Experimental design

For a broader perspective, six parks within the Midwest Region were selected for an experimental burn study. This study was funded in part by the Joint Fire Science Program (JFSP). Principal investigator for the research was Jay T. Sturdevant of the National Park Service Midwest Archeological Center. Co-principal investigators were Rod Skalsky, National Park Service, Theodore Roosevelt National Park, and Cody L. Wienk, National Park Service, Midwest Regional Office.

Sturdevant points out that fuel types and conditions in the Midwest are unique. “One of the primary justifications for our study was to explore the effects of fuel types specific to multiple areas in the Midwest/Great Plains. Previous to our study, the majority of research conducted on fire impacts to archeological resources had been undertaken in the western United States, where fuel types and fuel loads produce very different conditions.”

Sturdevant points out that areas that have previously been subjected to numerous prescribed fire or wildfire events may still be worthy of evaluation on potential

Park sites selected for archeological evaluation

- Buffalo National River, Arkansas. This site is located in the Ozark Highlands of north-central Arkansas and encompasses 94,000 acres along 135 miles of river. The park has an active prescribed fire program designed to promote and restore the Ozark woodland ecosystem. The park includes over 650 known archeological sites. The impact of fire at the historic sites is of particular concern because many have materials that could be damaged by fire, including wood, bone, shell and leather.
- Effigy Mounds National Monument, Iowa. Located in the Paleozoic Plateau in northeastern Iowa, this park contains 2,526 acres of high Mississippi River bluffs, valleys along the Yellow River, upland prairie and wooded hillslopes. There are numerous archeological sites in the park. The park has a prescribed fire program.
- Pea Ridge National Military Park, Arkansas. This 4,300 acre site encompasses the locale of the 1862 Civil War Battle of Pea Ridge. In addition to the archeological record of the battle, the site includes numerous prehistoric Native American sites and historic Euroamerican homesteads. Previous studies have documented that under certain conditions, battlefield materials such as lead can be damaged or destroyed.
- Tallgrass Prairie National Preserve, Kansas. This natural preserve covers 11,000 acres of rolling grassland in east-central Kansas. It is believed that some of the land, which until recently had been leased for cattle grazing, had been intentionally burned upwards of 70 times in the past 100 years. Archeological resources include prehistoric quarries where chert was obtained for stone tool manufacture, along with a number of historic farmsteads dating to the late 19th century.
- Voyageurs National Park, Minnesota. Positioned along the U.S.-Canadian border, this park encompasses 218,000 acres in the Rainy River drainage system, where the northern hardwood forest merges into the northern boreal forest. For thousands of years, fire has shaped the character of vegetation patterns. Over 400 archeological sites are recorded within the park and more remain to be discovered. These range from Late Paleoindian (circa 10,500 BP) through the early 20th century. Because of shallow soils, many sites contain near-surface deposits of artifacts.
- Wind Cave National Park, South Dakota. This park was created in 1903 as the first park to protect a cave. It has grown to encompass 28,295 acres and today includes a wide range of topographic features. Wind Cave is of major cultural significance for the Lakota and other Great Plains tribes, who identify the cave itself and surrounding areas as their place of origin.

damage from fires. He indicates, "Current fuel conditions may be unnaturally heavy because of decades of fire suppression, and may produce impacts that would not have occurred in the past. The build-up of fuels can be particularly damaging to archeological resources of more recent age—late 19th/early 20th century."

Sturdevant notes that NPS managers are usually very supportive of the need to protect cultural resources. "At times, managing multiple resource needs can be a challenging balancing act that requires detailed knowledge of each park. The purpose of our study was to provide park managers with a new set of information that could assist in decision-making when balancing the needs of cultural and natural resources."

The study was designed to address varying local fire conditions and potential impacts to archeological resources. The six sites were chosen to reflect the regional diversity of environmental zones, archeological resources and burn programs throughout the Midwest Region. Burn times and locations were chosen at each park to meet the needs of each park, at locations that reflected local burn conditions, using archeological materials representative of that park, and in conjunction with prescribed fires already planned and scheduled.

Research methodology

At each of the six sites, a multi-step comparative analysis was applied to study the effect on archeological resources. Information was collected on fuel types, fuel loads, fire temperatures and burn durations. Two study sites were located at each park, and each site incorporated three 20 x 20 meter experimental plots containing sample archeological artifacts. The experimental burn plots were then subjected to a different firing technique, including a head fire, a flanking fire and a backing fire.

The experimental artifacts included representative prehistoric and historic objects that might be found in each park. Prehistoric-period artifacts included stone tools, pottery, bone and shell. The samples of historic objects were more diverse and included stoneware, kaolin pipe fragments, bottle glass, lead munitions, metal tools, domestic wares and other objects unique to a particular park or site type.

Preparing for the prescribed fires

Artifacts were carefully documented before placement into the test plots in order to be able to evaluate all the changes after they had been exposed to the prescribed fires. A representative assemblage of 192 artifacts was used for each park with 32 artifacts per plot. The artifacts were arranged within each plot, with four artifacts clustered at each of eight points radiating from a central thermally-protected electronic data collection station. Each of the eight artifact locations was equipped with a thermocouple to gather temperature data next to the artifacts. Artifacts were placed at the surface below the leaf litter in the planned burn area.

The project team conducted the prescribed fire experiments at all of the parks between 2006–2009. Data on fire temperature and duration were recorded for all of the prescribed fires. Ignition of individual plots was done using head, flanking and backing fires. Following the fires, the artifacts were collected and subjected to detailed analysis, comparing post-fire condition with pre-fire condition.

The experimental plot included simulated near-surface artifacts and temperature sensors to collect fire intensity and duration data.

Post-fire processing

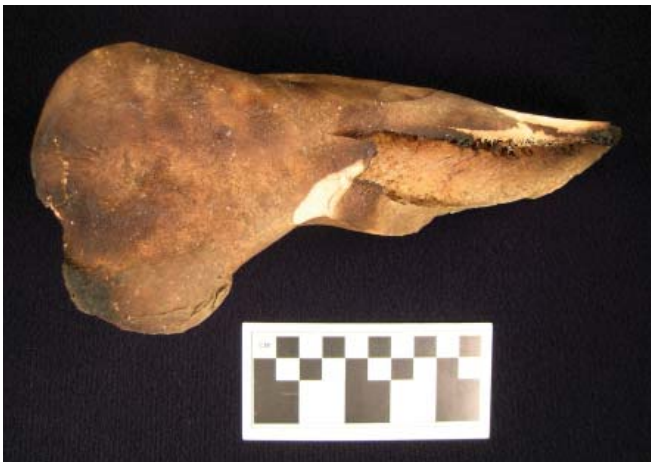
One group of 27 artifacts from the Pea Ridge site burn was chosen to gather information on post-burn artifact weathering. A test plot was established in Lincoln, Nebraska to expose the burned artifacts to seasonal weathering. The goal was to monitor the changes on a longer-term scale to assess the permanence of impacts resulting from the fire. The weathering plot contained a representative sample of material types and post-burn conditions. The plots were allowed to weather for 17 months and then re-analyzed and photographed using post-burn methods.

Eighteen artifacts were chosen for conservation experiments based on three criteria: material, fuel type where the artifact was burned, and degree of fire damage. Materials chosen were shell, ceramics, pottery, bone, ferrous metal, flaked stone, brass, tin, lead, pewter, and glass. Three bone and three flaked stone artifacts were chosen from different parks. Each was chosen with regard to fuel type, one each for grassland fuels, grassland-woodland fuels, and woodland fuels.

Finally, artifacts that showed more significant impacts such as medium combustive residue, scorching and charring were chosen to see if the worst fire effects could be removed. Using dry and wet cleaning procedures that had previously been developed, the artifacts were cleaned in a stepped process that began with dry cleaning with a soft-bristle brush, use of a groom-stick, and soot sponges. Next, wet cleaning was employed with weak detergents, and if necessary, more potent chemicals. Cleaning was stopped when an effective method was found.

Research results

Analysis of the effects of the prescribed fires on the artifacts has some expected results and surprises. Significant impact to an artifact was defined as irreversible change to the object and loss of its inherent information potential, destabilization that would lead to degradation, or complete destruction. Using this standard, the majority of artifacts did not exhibit significant impacts.



Some types of sample artifacts studied did show effects from prescribed fires. Here a bison bone shows the burn impacts of combustive residue and scorching.

The most frequently observed effect was adherence of combustive residue. Between 48 and 75 percent of artifacts exhibited low to high amounts of combustive residue. Most of the artifacts responded well to wet cleaning using simple, easily obtained detergents and water. A vast majority of the residue in the test areas on the artifacts was removed. Certain metals, bone and ceramics proved more difficult to clean. However, use of reasonably safe and easily obtained chemicals (ammonium hydroxide diluted with water, and ethanol) proved effective.

Despite this, unglazed portions of ceramics and charred/scorched portions of bone and other artifacts proved virtually impossible to clean. Corroded iron seemed to resist cleaning because of its very rough and pitted surface. Generally, it was concluded that conservation cleaning of an artifact is possible, and most effects of a fire, unless extreme, can be removed with a minimal investment of time and resources.

On a much smaller proportion of the artifacts—5 to 10 percent—significant impacts such as scorching, fracturing, cracking, spalling or melting were observed. Experimental plots with higher fuel loads or longer burn residence times did increase the occurrence of these impacts into the 20 to 25 percent range. Plots with these more significant impacts included Buffalo National River, Voyageurs, and Wind Cave.

Artifact materials such as bone, shell, leather, wood and lead exhibited more frequent significant impacts when compared to ceramic, stone, metal and glass. The majority

of impacts observed were judged to be of a minor variety based on the definition of a significant impact. However, this study has also demonstrated that under the right burn conditions, serious impacts and significant damage can occur to certain types of archeological materials leading to a loss of information.

Understanding the results

Fuel Variability—The study showed considerable variability in fuel levels and corresponding burn durations and temperatures, both between different parks and within the parks. These differences influence the level of impact on artifacts. Thus, an evaluation of the fuel conditions is a key to predicting potential impacts on artifacts. Sturdevant explains, "Duration and temperature of prescribed fires act in concert to produce impacts on archeological resources. When both increase, there is more likelihood of negative impacts."

Cleaning Techniques—The project demonstrated that with the exception of bone and some ceramics, most of the artifact materials with minor impacts such as combustive residue responded well to wet cleaning using mild detergents and water. The unglazed portion of ceramics and bone materials absorbed combustive residues into the interior material and proved virtually impossible to clean. Most effects of fire, unless extreme, can be removed with minimal investment of time and resource.

Permanence of Impacts—Most of the impacts observed in the post-burn analysis were non-permanent and removable. Those impacts of a more permanent nature could not be reversed, but occurred infrequently.

Comparison of Firing Techniques—Inconclusive results were achieved in comparing firing techniques and trying to determine their effect on the artifacts. Generally speaking, when the fuel is uniform, the data suggest that the head fire has the shortest flame exposure duration and the highest maximum temperature, and the backing fire has the lowest temperature and the longest duration. Additional research is needed to better understand these relationships between firing techniques and impacts to archeological resources.

More work needed

Sturdevant emphasizes that this study was only the first step to establish some baseline data on the fire-archeology interface in the Midwest Region. "Many questions still remain and will require additional study." One of the main areas for future study is the cumulative impacts from prescribed fires. Sturdevant asks, "Do repeat prescribed fires improve conditions and reduce the threat to archeological materials or do they introduce cumulative impacts that can lead to the loss of archeological objects and information? At this time, no long-term studies have been initiated."

Management Implications

- This study resulted in a better understanding of the role of prescribed fire on archeological resources is now possible. It is now possible for managers to focus efforts on protection of those archeological resources that might actually be jeopardized by fire to reduce or mitigate potential impacts.
- Through an improved understanding of the effects of prescribed fires, Federal land managers and fire personnel will be able to more effectively review fire programs under Section 106 of the National Historic Preservation Act. It can now be demonstrated that there are fire conditions within the Midwest Region that may not adversely affect archeological resources, and some conditions where fire could cause serious damage.
- The research project demonstrated effective collaboration between the NPS Fire and Archeology programs. Continued dialogue and collaboration will strengthen both programs, helping to meet the needs of NPS units throughout the Midwest Region.
- In order to evaluate the potential impact of a prescribed fire on archeological resources, it is now known that a careful fuel characterization is essential.
- It is also important to understand the types of potential archeological resources that might be at risk in a prescribed fire zone, ranging from resources with a low risk of permanent damage, such as stone, glass and ferrous metals to higher risk resources such as shell, bone and lead.
- This project helped to identify where more information and study are needed. Additional research is needed to address the long-term cumulative impacts of fire and also its effects on non-artifact based types of data (i.e., remote sensing, radiocarbon dating, and other types of scientific analysis).

Further Information: Publications and Web Resources

Buenger, Brent A.; *the Impact of Wildland and Prescribed Fire on Archeological Resources*; Unpublished Ph.D. dissertation, Department of Anthropology, University of Kansas, Lawrence, Kansas; 2–3.

Sturdevant, Jay T.; *Experimental Study of Local Fire Conditions and Effect on Surface or Near-Surface Archeological Resources at National Park Service Units—Midwest Region*; Joint Fire Science Program Final Report, Project Number 06-2-1-05. 2009.

Archeology in the National Parks: http://www.nps.gov/archeology/sites/npSites/fire.htm

Midwest Archeological Center: http://www.cr.nps.gov/mwac/

Scientist Profile

Jay Sturdevant is currently an Archeologist at the National Park Service's Midwest Archeological Center (MWAC) in Lincoln, Nebraska. Mr. Sturdevant works in the MWAC Park Program assisting NPS units throughout the Midwest Region with their archeological resource needs. Previously, Mr. Sturdevant was employed at two other NPS units, Dinosaur National Monument and the Southeast Archeological Center. During his eleven years with the NPS. Mr. Sturdevant has conducted archeological projects at thirty-nine NPS units across the country. His current research interests include historical archeology of the 18th–19th century fur trade, Great Lakes and Northern Plains Native American cultures, and processes influencing archeological site formation and modification.

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