

TO BURN OR NOT TO BURN

Effects of fire as management for Tallgrass Prairie: A case study from George Washington Carver National Monument

Suggested Audience/Age Group: High School Biology and Ecology, (*aligned to Missouri Biology Course Level Expectations*).

Goals:

- Educate students on the effects of select management techniques on tallgrass prairie **ecology**.
- Develop an appreciation of and justification for maintaining the historic prairie **ecosystem** within a national park such as George Washington Carver National Monument.
- Foster understanding toward a sense of stewardship for national park resources.
- Introduce students to research methods (field sampling, data collection and analysis).

Objectives:

Upon completion of this lesson or activity, students will be able to:

- Interpret and analyze data relative to **prairie** land management techniques.
- Describe ecosystem processes such as fire, grazing, and climatic conditions.
- Predict the impact of natural or human caused disturbances that may affect the biodiversity and occurrence of invasive species in the prairie plant community.

Background or Discussion Information:

George Washington Carver National Monument consists of all 240 acres of the Moses Carver farm. The visitor center includes a museum with exhibits that trace George Washington Carver's life from being born into slavery and growing up on the Moses Carver farm to his role as an artist, educator, and humanitarian as well as a scientist.

The young boy known as the "Plant Doctor" tended his secret garden while observing the day to day operations of a successful 19th century farm. His experiences on the farm and in the natural setting of **tallgrass prairie** and surrounding woodlands ultimately influenced George on his journey to becoming a world renowned scientist of agriculture.

For more background information on George Washington Carver National Monument see <http://www.nps.gov/qwca/index.htm>

Explain the importance of the public presentation of scientific work and supporting evidence to the scientific community (e.g., work and evidence must be critiqued, reviewed, and validated by peers; needed for subsequent investigations by peers; results can influence the decisions regarding future scientific work such as land management decisions). Refer to <http://science.nature.nps.gov/im/units/htln/>

The prairie area of George Washington Carver National Monument is part of a section of MO known as the Prairie Ozark Border, categorized by dry-mesic (moderate amounts of moisture) soils covering chert/limestone (specifically, dolomite) bedrock. As mentioned previously, this area historically would

have been tallgrass prairie, which means that it was composed of warm-season grasses such as little bluestem, big bluestem, and sideoats grama, with few trees, except near water sources (there are two creeks that run through George Washington Carver National Monument). These plants (and all other prairie plant species) will typically have long, deep root systems which allow them to gain water from deep within the soil. The growing part of the plant is also just below the surface, which allows the blades of grass above ground to gather sunlight for photosynthesis, but protects the growing points from both grazing animals and fire. Historically, bison grazed many prairie areas, but today cattle benefit from planted agricultural grasses and hay (fescue, clover, etc.) grown in previous prairie areas.

If left on their own without grazing or fire, prairie areas tend to have more trees and **invasive plant species** over time. Ecological **succession** takes over and trees and shrubs such as sumac, persimmon, Eastern red cedar, blackberry, honey locust, slippery elm, and osage orange will begin to grow. Other plant species that will grow instead of prairie grasses include many **nonnative** (also called **exotic**, alien, etc.) plant species such as multiflora rose, crown vetch, *Sericea lespedeza*, and autumn olive. Even planted grasses such as meadow and tall fescue, yellow sweet clover, Johnson grass, and Kentucky bluegrass can take over an area and become a monoculture (a situation in which they will kill off all other species and become the only species present in an area). When plants are altered in an area, it also affects the local wildlife in the area—eg. small animals feed upon seeds of a plant and if that plant is no longer available, then they must move to another area. Some species such as the Greater Prairie Chicken not only need certain plants to survive, they also need large areas of prairie to survive—having fragmented patches of prairie land (meaning there is small, disconnected prairie unusable habitat between them) does not give them enough space.

Before settlement in this area of the state (even before George Washington Carver's time), the prairie lands would have been maintained by natural fires (lightning), some fire by Native American groups, grazing by bison and some elk, drought, and even insects as herbivores, such as grasshoppers and crickets (students may remember reading the *Little House on the Prairie* series and the story about the grasshoppers invading and eating everything. Laura Ingalls Wilder remembered the sound of them chewing day and night). Current **management techniques** to control or manage a prairie area include grazing by animals, haying, spraying of chemicals, and fire. All of these methods allow for prairie plant species to grow and flourish, but also keep the woody plant species numbers low. All of these methods are currently used at George Washington Carver National Monument, except grazing by animals. Grazing in the park was used in the 1980's to early 1990's. Because most students are familiar with the concept of cattle grazing in a field, haying (or at least they have seen it done), and spraying chemicals (they may have done this on their own property to control weeds, etc.), this lesson will focus on the use of fire as a management tool.

It has been estimated that historically, fire due to lightning or to Native American influence burned over most prairie patches every 1-5 years. Historical records also show that most fires occurred in the fall of the year because of burning by Native Americans, although lightning fires occur mostly in the spring and summer during thunderstorm months. Today's inhabitants no longer set fire to the landscape (for the most part), and prairie areas are too small and isolated to be ignited by lightning; therefore, **prescribed fire** or prescribed controlled burns must be done. The season when an area is burned, along with the frequency of burns depend on the rate and extent of woody plants, the need to get rid of nonnative or even **invasive** plants like Eastern red cedar, the type of prairie and the amount of fuel accumulation (dead grasses, any tree material down, etc. serve as fuel for a fire). Over time, Missouri lands have accumulated more leaf litter from trees, more small trees growing in what were once prairie areas, and

more shrubby-type plants growing, which create more fuel for fires. Fires are even used in other areas besides prairies—**savannas** (forested areas in which the trees are spread further apart and ground cover is close to the ground, rather than brambles, etc.) and heavily forested areas to get rid of shrubby species.

When prescribed fire is used today, care must be made to evaluate the surrounding topography or landscape. Slope and terrain of the area can influence the rate of the spread of the fire, as well as the density of vegetation and moisture level in the soil. (George Washington Carver National Monument's prairie patches are generally flat terrain). The effects of fire will be analyzed in this lesson.

For additional information, go to www.firelab.org/science-applications/sciencesynthesis/75-fireworks

The following information explains the history and Management Plan for the George Washington Carver National Monument natural areas.

Pre-Management, 1977-1981

The staff of George Washington Carver National Monument began consultation with experts about the proper care of the native prairie area and were advised to use controlled burning, cultivation, and later reseeding of one part of the prairie. The lack of a Resources Management Plan created a problem for instituting prairie management practices at the time.

Prairie Restoration Action Plans and Monitoring, 1982-1993

Little remnant prairie vegetation remained. Much of the remaining park acreage was involved in an agricultural lease program which included cropping and grazing. A Prairie Management and Monitoring Program Phase II Report was completed and provided a much more detailed picture of the restoration effort. The purpose was to provide the "third series of management recommendations for the maintenance and perpetuation of prairie areas, within George Washington Carver National Monument, which are appropriate to the historic scene of 1860-1880." With this evaluation, the authors were able to provide direction for the 1982 and 1983 management actions.

Updated Management Practices, 1995-1998

Resource Management Plan developed by the GWCA Staff was also completed in 1999, which discussed the state of natural and cultural resources at GWCA, and how to preserve and promote those resources.

Heartland Network

The Heartland Network Inventory and Monitoring Program has initiated several reports on the ongoing restoration of tallgrass prairie at the park.

Classroom Activity: Fire Management Lesson

Materials:

- Site photos (aerial map of park, examples of native and non-native invasive prairie plants, fire scenes, GWC portrait, etc) provided on enclosed disk and listed in *Resources*.
- Handouts (may be downloaded from disk), 1 set per student or student team:
 - Data tables for sites #3 and #4 (Heartland Network)
 - George Washington Carver NM Burn History illustration
 - Prescribed Fire Monitoring Report
- Field Guides for Missouri Prairie Plants (flowers, grasses, shrubs) and /or internet access
- Graph paper, poster paper

Key Vocabulary Terms:

A working knowledge of the following items is assumed throughout this activity.

Ecology, tallgrass prairie and savanna ecosystems, ecological disturbance, biodiversity, ecological succession, prescribed fire, wildfire, management techniques, native plant species, non native plant species, exotic species, plant guilds (groups), forbs, woody plant species, warm season grasses, cool seasons grasses

Time Required: 1-2 class periods, dependent on time allowed for introductory discussion and writing prompt.

Procedure: *To be done in the classroom.*

Anticipatory Set

Writing Prompt: "George Washington Carver lived on a farm near Diamond, Missouri during the years following the Civil War. Describe what you think his natural surroundings might have looked like during this time. Include at least two examples of plants and animals that he may have experienced."

After giving students approximately 5 minutes to work on this, ask for any volunteers who might be willing to either read their paragraph OR tell the class what they think the natural surroundings might have looked like. Ask for any other volunteers or for students to contribute a list of plants and animals that would have been found in the area.

Engage

Show students photos of the study site. Include aerial pictures, fire footage (a video of fire footage at Homestead National Monument of America can be found at <http://www.nps.gov/home/photosmultimedia/multimedia.htm>), native prairie landscapes, historical references to GWC, etc. (photos are included in reference CD; they could be made into handouts or displayed as a Power Point presentation).

- Initiate the topic using the background and discussion information described above. Key topics to discuss include a bit about George Washington Carver (and the purpose of the

park); the purpose of scientific study; background on prairie areas and how George Washington Carver National Monument fits into the prairie discussion; and the use of prairie and grasslands management (including fire). Teachers may decide to give a few notes over these topics or provide some of the background information to students and have them read as homework or use a reading strategy to ensure good reading comprehension.

- Review Key Vocabulary Terms
- Distribute handouts: aerial photo, site-marked map, Prescribed Fire Monitoring Report (data tables)

Exploration: *Students should:*

- Locate the test sites on the map. Compare and contrast management practices that have been used on each site as referenced in the Prescribed Fire Monitoring Report and fire history. Students can write their answers on a sheet of paper.
- Write a prediction about in which site you would expect to find a larger concentration of non-native species and on which site you would expect the greatest **biodiversity**. Justify these predictions and write your answers on your paper.
- Acquire plant data collected from site # 3 and site #4, from the Plant Community Monitoring Data sheet. TEACHER NOTE: the data covers 3 years—2004, 2005 and 2008, along with designations for types of **plant guilds** or groups for one set of data and designations of native and exotic plants for the other set of data. It may be helpful for students to use different colored markers or highlighters to help them group data together. You could also separate out the data by group member and have one person look at only the plant groups from 2004, while another student gets the info about 2005, etc. That might also help groups make sense of the data. Or, they might create their own data table to help them keep it all straight, which could be a good authentic example of the use of a data table.
- Use field guides or web resources listed in the Resource section to get pictures of at least 8 of the most common plants listed in the data tables. (This will be especially helpful if the Enrichment Activity is included in this lesson).
- Create a pie graph that illustrates the variety of plant guilds or groups that are found in each site over the three sample periods or years. See teaching note above at bullet #3.
- Create a bar graph that compares the number of **native** to **exotic** or nonnative **plant species** found in consecutive years for both collection sites. See teaching note above for bullet #3.
- Based on the data table and graph, analyze the results of this ongoing study. In reference to the pie graph, which plant group or guild is most abundant in each site? Is it the same plant group for each sample period? Why or why not? Which plant group or guild is the least abundant? Are those results consistent for each sample period?
- In reference to the bar graph comparing native to exotic plant species, which group is most abundant, native or exotic? Is this consistent over the years of study for the collection sites? What affect have management practices had on the frequency or abundance of exotic species? What can account for the lower number of exotics in 2008?
- Looking at both graphs, what affect have management practices had on the range of biodiversity found on sites 3 and 4?

- Form a reasonable conclusion that relates the management practices used to the frequency or abundance of exotic species and to the range of biodiversity found on each site.

Assessment: students will

1. Hypothesize, graph and analyze data pertaining to vegetation changes from two test sites located at the National Monument.
2. choose one of the following:
 - Using the data analysis and conclusion, describe in an essay how fire, as an example of a **disturbance**, in a natural prairie may affect the plant biodiversity and quality of the **ecosystem**. Explain how this activity influenced your ideas of land management (prescribed fires in particular). Report to the class.
 - Create a visual image (poster) that describes the ecology and succession found in a tallgrass prairie relative to its management. Present and describe your poster to the class.

Answers/Scoring Guide—located at end of lesson

Primary Interpretive Themes: Theme 1

Vegetation restoration and management: restoration of the scene of the historic and culturally significant resources of the National Park site. In doing so, scientific data is used to combat invasive species with a variety of tools, including prescribed fire.

Missouri Course Level Expectations:

- 4.1.D.BIO.a
- 7.1B.BIO.a
- 7.1C.BIO .a-d
- 7.1D.BIO.a
- 7.1D.BIO.d

Missouri Process Standards:

- Goals: 1.6, 1.8, 2.1, 3.5,

Resources:

- George Washington Carver National Monument website <http://www.nps.gov/gwca>
- Data and additional information provided by Heartland Network Inventory and Monitoring Program www.nps.gov/im/units/htln/index.htm
- Plant information <http://www.missouriplants.com>
- Plant Information <http://plants.usda.gov/java/profile?symbol=HYVE>
- Plant Information <http://www.missouriwildflowerguide.com/>

Enrichment Activity: Road Trip! Let's collect our *Own Data!*

Review Background Information, Key Terms, and Management Techniques used in the park as discussed in previous activity. Emphasize student generated conclusions based on Heartland Network data.

Materials required: field note pad and pencil, 1 plastic ring (hula-hoops work) per team, measuring tape or meter stick, prairie plant field guides, list and description of Plant Groups or Guilds used in original activity;

Time Requirement: 1 hour at collection site-George Washington Carver National Monument, Diamond, MO (*Please call park staff to make arrangements.*)

Exploration:

It is recommended that students have an opportunity to spend time in the visitor center to view displays.

- Students should work in groups of two (or three for an odd number of students).
- Refer to maps to locate actual test sites # 3 and #4 used in the original activity.
- Create a data table using the list of Plant Groups or Guilds as column headings. Refer to field guides as necessary.
- Use the plastic ring and randomly toss it onto test site # 3.
- Count and record the number of plants from each of three groups or guilds found inside the ring.
- Repeat this procedure for test site #4.

Data Analysis: (*may be done in the science classroom inside the park visitor center, or offsite, back in the classroom*).

- Calculate the area of ground that the ring covers.
- Convert the numbers in each guild category to a percentage of the total number of plants inventoried. Create a pie graph that illustrates these differences. Compare and contrast the findings at site #3 and #4.
- Discuss the results of each group with the class and put together the information as a class
- Combine the data from each group and average the findings. Base the analysis and conclusion on this class set of information and discuss why some individual plots may have results that differ from the average results. More data means more meaningful information!

Conclusion:

How does the data that you collected on site compare to your conclusions on disturbance and biodiversity in the original activity? Suggest changes or additions that you would make to improve the quality of this study. List 3 questions about prairie management that this investigation made you think of.

Reflection:

If George were here today would he recognize his home? What plants and animals might he miss from his boyhood? What plants and animals would he recognize from his boyhood?

Answers/Scoring Guide for Fire Management Lesson

Exploration Section:

Compare and contrast management practices used at George Washington Carver National Monument:

Compare: All management techniques used are meant to rid area of excessive numbers of woody plants and exotic species, while letting native plants and grasses grow.

Contrast: Fire—burns all of the area and grasses

Mowing—cutting grass, as well as woody plants and exotics

Grazing—animals cut the grass, but may leave some woody plants or exotics

Chemical spraying—kills all plants in the area or may be specific to certain types

Pie Graph: See Teacher Data Set for Pie Graphs for Plant Guilds

Bar Graph: See Teacher Data Set for Bar Graphs of Native and Exotic Species

Questions about Plant Guilds:

The most abundant plant guild for both site #3 and site #4 are Forbs. It is the same for each sample period or years and the reason could be that it takes a while for plant species to change in an area—maybe longer than the 4 years of this data. The least abundant for both sites are woody plants and this is also consistent.

Questions about Native and Exotic/Nonnative Groups:

The native plants are more abundant overall. Management practices have reduced the number of exotic plants. At Site #3 there were 11 exotics in 2004, 8 exotics in 2005 and 10 exotics in 2008. At Site #4, there were 13 exotics in both 2004 and 2005 and only 1 exotic was recorded in 2008. The number of exotics could have been low in 2008 because the burns in 2004 and 2005 killed the plants.

Question about Biodiversity:

Range of biodiversity for Sites #3 and #4—there are more native than exotic species present. Tall Fescue (an exotic) was not recorded for Site #3 after 2004, and other answers may vary. In addition, some native species are no longer recorded and/or are replaced by other species.

Conclusion:

Conclusions could say something to the effect that fire management has cut down the number of exotic species at the park, especially for Site #4. They could also say that more years are needed or more data needed to make a conclusion, if they take into account Site #3 didn't have dramatic change as seen in Site #4.

Assessment:

Essay: First, students should include information about fire and how it influences biodiversity and quality of the ecosystem. Second, they need to address how this activity affected their thinking about land management techniques.

Poster: Posters should address both ecology and succession in a tallgrass prairie, as well as how a specific land management technique affects the prairie.

Glossary

Biodiversity a measure of the variety of organisms within a local area or region.

Disturbance any event that disrupts an ecosystem, community or population and changes resources or the physical environment.

Ecology study of the relationships between organisms and the environment.

Ecosystem a biological community, plus all abiotic factors that influence the community.

Exotic species non native species. In this lesson, *exotic* and *non native* are synonyms for one another.

Forb herbaceous plant (without a woody stem) and not including grasses

Grasses, Cool Season grasses that exhibit peak production during spring or fall (cooler months). Many non native grasses are cool season grasses.

Grasses, Warm Season grasses that exhibit peak production during the summer or warmer months. Native grasses are dominated by warm season grasses.

Invasive species non native species that have no natural predators or control on their growth and can overpopulate an area.

Management techniques or practices methods used by natural resource or agency employees to maintain an area for organisms, or to rehabilitate an area after damage. The use of prescribed fire is a management technique.

Native plant species plants that are part of the original vegetation of an area.

Non native plant species Plants that are originally from another area or country and have been introduced to an area. Non native plants are also called “exotics” and can become invasive in their new surroundings.

Plant guilds specific groups of plants as part of a study or experiment

Prairie land, typically level or rolling, that is covered mostly with grass (and a few trees). In the US, this area is located in the central part of the country.

Prescribed fire a fire that is intentionally set and serves a specific purpose in the management of an area. Sometimes called a controlled burn.

Savanna forested areas in which the trees are spread further apart and ground cover is very close to the ground or is sparse.

Succession the gradual change in plant and animal communities in an area following disturbance.

Tallgrass prairie a prairie area, characterized by big bluestem, Indian grass, switchgrass, prairie Cordgrass, and eastern gama grass. Big bluestem is the most abundant grass found in a Tallgrass prairie ecosystem.

Wildfire a fire that begins either intentionally or unintentionally, but is typically considered to be out of control.

Woody plant species plants with a woody stem such as trees and shrubs.

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