Introduction

This activity is based on the US Forest Service's "FireWorks Northern Rocky Mountains & Northern Cascades" Curriculum

FireWorks: Why?

Change is an integral part of a healthy, enduring ecosystem. *FireWorks* provides students with interactive, hands-on materials to study the forces that cause change in ecosystems, particularly wildland fire. *FireWorks* provides teachers with a flexible curriculum linked to national and state educational standards. Teachers can use the curriculum for specific class levels. We extensively revised select lessons from the original curriculum to work with the Tallgrass prairie ecosystem and meet the new learning standards. Note that we kept the numbers of the lessons the same as the original versions, to make it easier to cross-reference them. The original FireWorks focused on forest ecosystems can be found here: www.frames.gov/partnersites/fireworks/curriculum.

The lessons with the specific "Tallgrass Prairie" flame are structured for high school level classes, whereas the *FireWorks* for Sagebrush and Forest ecosystems offer some lessons for primary, elementary, and middle school levels. All lessons are adaptable for other grades. In addition, lessons can be selected individually or by theme (chapter) from the curriculum. The curriculum addresses several topics and suggests field trips that will help students integrate learning.

Subjects: Throughout the *FireWorks* curriculum, you will see a box like this that offers a quick-view guide of what to expect/need.

Duration: Length of time to do entire lesson

Group Size: Suggested group size that works best for each lesson. Class may be divided into sizes

Setting: Classroom, outdoors, or laboratory are all options

Vocabulary:

Symbols: Fire means fire will be involved; Box means items will need to be purchased or can be found in the "trunk"

The science of wildland fire provides a context for learning about properties of matter, ecosystem fluctuations and cycles, habitat and survival, and human effects on ecosystems. These concepts are considered benchmarks for science literacy (American Association of the Advancement of Science 1993). Students using *FireWorks* ask questions about new subjects, gather information, analyze and interpret it, and communicate their discoveries. They often work in pairs or small groups. These are learning styles that enhance understanding, cognitive skills, and social skills (Moreno 1999; National Research Council 1996).

Students learn best about ecology when it is close to home – when they can study the plants, animals, and fire regimes typical of local ecosystems (Lindholdt 1999; North American Association for Environmental Education 1999). *FireWorks for the Tallgrass Prairie* uses hands-on materials to describe the fire ecology of the tallgrass prairies of the great plains region.

Several excellent programs are available for studying fire ecology throughout the U.S. and *FireWorks* draws upon many of them. Investigating the most interesting aspects of wildland fire, however, requires special materials. Access to pictures of about local plants, animals, and fungi are examples. Laboratory equipment is helpful, as well. Hoping to share the excitement of learning first-hand about fire, we have developed this educational "trunk". For learning about the tallgrass prairies, however, there is nothing as good as being out there! We encourage you to go on a field trip after studying *FireWorks.* Contact someone at your local land management agency, state wildlife and parks, or extension office to see if a professional ecologist, biologist, or fire manager can provide a guided tour; the outdoor experience and contact with people who work in the field may capture the attention of your students and help them integrate what they have learned.

Lesson Goals:

FireWorks has been developed by the U.S. Department of Agriculture and the Great Plains Fire Science Exchange to increase student understanding

- Of the physical science of combustion, especially in wildland fuels
- That grasslands have many kinds of plants and animals which change over time and influence one another
- That fire is an important natural process in many tallgrass prairie ecosystems
- That native plants and animals have ways to survive fire or reproduce after fire or both
- That people influence fire-dependent wildlands in the areas where they live and
- That people respond in different ways to fire-related questions

Meeting these goals contributes to implementation of the recommendation from the Federal Wildland Fire Management Policy and Program Review (U.S. Department of Interior and U.S. Department of Agriculture 1995) to "transmit a clear message about the important role of fire as a natural process."

To enhance scientific literacy and critical thinking about science-related social issues among students, *FireWorks* aims to increase student skills in

- Making observations

- Classifying information
- Measuring, counting, and computing
- Stating and testing hypotheses
- Describing observations, both qualitatively and quantitatively
- Explaining reasoning
- Identifying and expressing responses to science-related questions
- Working in teams to solve problems and
- Critical listening and reading

These skills are crucial for developing an adult citizenry literate in science and attracting students to professional work in the sciences (National Research Council 1996).

Fire in North America:

For thousands of years, fires have shaped the wildlands of North America. But wildland fires are not all the same and they never have been. For instance, fires burned some grasslands nearly every year, while some forests and wetlands escaped fire for centuries at a time. In forests, some fires burned only grass and low shrubs under the large trees, others killed nearly every tree, and still others produced a mosaic of fire-killed trees and patches left unburned because of random changes in wind direction or other conditions (Brown and Smith 2000). Within large, severe burns, some patches remain unburned because of changes in wind direction, weather, and other conditions. The story of fire plays out differently in nearly every plant and animal community on the continent.

North American plants and animals persisted for thousands of years in the presence of fire. Many species thrived when their homelands burned at predictable intervals. Not surprisingly, some have developed traits that enable them to take advantage of fire to reproduce successfully or compete with other species (Miller 2000). You will investigate man of these traits in *FireWorks* activities. Some wild plants and animals are actually harmed if fire is **excluded** from their habitat, so land managers attempt to reintroduce fire and use naturally occurring fires to benefit these landscapes. Professional work that includes preventing fires, putting them out where they are likely to produce damage and using them to benefit the land is called *fire management.* Students using *FireWorks* have opportunities to try their hand at making fire management decisions.

The table below lists historic fire regimes by group. The tallgrass prairie has historically been in Group 2

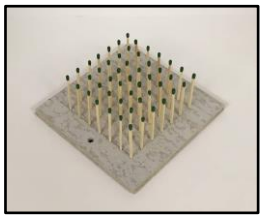
Historic Fire Regimes				
Group	Frequency	Severity	Description	Example
Group 1 Frequent, low severity fires	1-35 years	Low/Mixed	Burns 25-75% of vegetation in mosaic pattern	Ponderosa pine forest
Group 2 Frequent, stand replacement fires	**0-35 years**	**High/Stand replacement**	**High severity fires that burn over 75% of vegetation**	**Prairie grassland (Great Plains)**
Group 3 Moderate to low frequency, low severity fires	35-200 years	Low/Mixed	Like Group 1, but with a longer return interval	Salt desert shrub
Group 4 Moderate to low frequency, stand replacement fires	35-200 years	Stand replacement	High severity fires that replace over 75% of vegetation	Sagebrush steppe

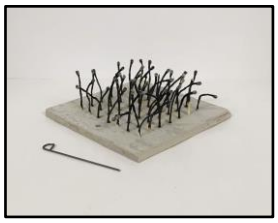
Group 5 Low frequency, mixed severity fires	200+ years	Mixed/Stand replacement	Generally, stand replacement, but may include mixed severity	Coastal spruce – cedar - hemlock

Lesson Plan Format:

Each lesson has the following sections:

- **Overview**
- **Lesson**
- **Goal(s)**
- **Objectives**
- **Alignment to Standards**
- **Teacher Background**
- **Materials + Preparation**
- **Procedure**
- **Assessment**
- **Evaluation**





Each lesson also includes a text box (example above) that lists subjects covered, the average duration of the lesson, setting (laboratory, outdoors, etc.), and vocabulary (list of terms in the FireWorks Glossary that are first introduced in the lesson). Note: FireWorks Trunks are available free from BLM offices to support the curriculum, but most materials are also readily available elsewhere or can be downloaded if you do not have a trunk on loan. Materials meant for teachers all begin with bold-face headers in white or **red text**. Handouts and other materials meant for students all begin with a large, bold-face header in **blue text**. Exceptions are listed in the Appendix, such as the glossary, which is a resource for both teachers and students.

Alignment to Standards:

FireWorks need not compete with core curriculum for classroom time. Instead, it can help teachers cover core concepts and improve student skills by using hands-on materials based on science from their own local area. To help teachers identify the ways in which FireWorks can be used to meet their curriculum requirements, each lesson is correlated to:

- the **Next Generation Science Standards (NGSS)**
- the **Common Core State Standards** in English Language Arts (ELA) and Math
- the **Excellence in Environmental Education: Guidelines for Learning (K-12) standards (EEEGL).**

A chart like the one below is included in each lesson plan which lists the standards met.

Standards		High School (9-12)
NGSS – Disciplinary Core Ideas	**Crosscutting Concepts**	• Stability and Change • Systems and System Models
	Science & Engineering Practices	• Developing and Using Models • Obtaining, Evaluating, and Communicating Information
	Disciplinary Core Ideas	PS1.A: Structure and Properties of Matter PS1.B: Chemical Reactions ETS1.A: Defining and Delimiting an Engineering Problem
NGSS – Performance Expectations	**HS-PS3 Energy**	• HS-PS3-4

Note:

• Numbers and letters listed for the standards correspond to those in the respective sections of the standards. Links to the standards are provided in the References section at the end of this introduction.

• Lessons are designed to meet multiple standards, but due to space considerations, those listed may not be completely comprehensive. Educators are encouraged to reinterpret standards and lessons and adapt lessons to meet their educational objectives and specific standards.

Safety:

Many of the experiments in this curriculum use fire and natural fuels in the classroom or laboratory. In these structured, well-supervised environments, students can make discoveries about fire and improve their habits regarding fire safety. Help students learn about safe laboratory practices, such as using protective eyewear and wearing appropriate clothing. Help them learn that professional skills and years of experience are needed to use fire safety in wildlands.

The following steps will help make a safe environment and assist your students in growing in responsibility and competence regarding lab safety and fire:

• Inform your maintenance staff about activities in which you will use fire.
• Inform your local fire protection unit if you plan to use fire outdoors.
• Consider informing parents and administrators about your plans and goals for teaching about fire.
• Choose your workspace carefully, especially if you will not be using a laboratory. The fire engine must respond to every alarm, even if you tell them it's “only” an experiment.
• If you are working outdoors, watch carefully to prevent smoldering material from igniting schoolyard vegetation.

• Keep spray bottles filled with water. Have students use them to extinguish smoldering material at the end of each experiment. This will prevent trash-can fires.
• If you are working outdoors, keep a hose available and ready to use. Have a bucket or two of water available, as well.
• Keep a fire extinguisher ready for use. Know how to use it. If you discharge a fire extinguisher, refill or replace it immediately. Don't burn anything without a charged fire extinguisher in the room.
• If you or any of your students have asthma or other respiratory problems, consider having them wear protective masks while working with fire.

Place-Based Learning in the Tallgrass Prairie Ecosystem

Students learn best about ecology when it is close to home—when they can study the plants, animals, and fire regimes typical of local ecosystems (Lindholdt 1999; North American Association for Environmental Education 2010). This version of the FireWorks program focuses on the tallgrass ecosystem located close to many students throughout the Great Plains, a vast and diverse area containing 500+ species. The **tallgrass prairie** supports a wide variety of **species** containing around 150 **species** of birds, 30 reptiles and amphibians, and 31 mammals. A large component of the ecosystem is the sagebrush steppe (also known as the high desert), which occurs mainly in the high elevation flat lands of the western United States. It contains dense patches of shrubs, grasses, and forbs (wildflowers), as well as patches of timber, such as juniper. Historically, the steppe was a vast area with bunch grasses and shrubs with open spaces between. Due to this open spacing between vegetation, intense fires were rare in the high desert, and a stand replacement fire occurred only about every 50 – 100 years on average. Low intensity fires were common between stand replacement fires. These fires typically remained on the ground, cleaning up litter and duff, not harming the larger shrubs.

The tallgrass prairie ecosystem is bounded by the oak-savanna prairies to the east and the mixed grass prairie to the west and is located in the central United States. It is characterized by robust bunchgrasses, numerous forbs, and a scarcity of trees and brush. Historically, a frequent fire interval (1-5 years) kept the prairie ecosystem free from encroaching woody species and sustained grassland species. Fires were rapid and carried readily through the continuous fuel loads of the tallgrass prairie. Litter and duff were removed with each fire, and regrowth from grass meristematic tissues was rapid (within a growing season). The interaction between prairie plant species and grazing fauna was important and shaped the intensity and extent of fire as well as wildlife grazing patterns. Tallgrass prairie was managed extensively with fire by tribal groups prior to European settlement. Along riparian areas and where protected from frequent fires by rocky outcrops or other natural features, oak woodlands and cottonwood stands developed.

Much of the intact tallgrass prairie ecosystem has been lost to cultivation and development and by conversion to woodlands through fire exclusion. Historically tallgrass prairie provided habitat for plains bison, prairie dogs, elk, gray wolves, pronghorn, pumas and greater prairie chickens, as well as many other faunal species. Many of these species no longer have widespread populations in the tallgrass prairies and are found only sporadically or where introduced. Wildlife species of concern today include the Topeka shiner, regal fritillary butterfly, and the greater prairie chicken among others. Prescribed burning is frequent in some parts of the tallgrass prairie, but woody encroachment has occurred over large areas of the landscape due to a decrease in fire use and intensity

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