Introduction to the FireWorks Curriculum
Featuring the Sagebrush Ecosystem

Welcome! This version of the *FireWorks* educational program (Smith and McMurray 2000) features the sagebrush ecosystem, the largest in North America. It is targeted to middle school students in grades 6-8, but can be adapted to meet the needs of all learners, including younger and older students. The ecology of southern and eastern Idaho is highlighted, but it is applicable to the sagebrush ecosystem areas found in 10 other western states, as well: Oregon, Washington, Wyoming, Montana, Utah, Nevada, California, North Dakota, South Dakota, and Colorado.

Photo courtesy Gerrit Vyn, from *Nature's* The Sagebrush Sea

We extensively revised select lessons from the original curriculum to work with the sagebrush ecosystem and meet the new learning standards, as explained below. 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/partner-sites/fireworks/curriculum.

Goals

FireWorks aims to increase understanding that:

- Properties of physical science explain combustion, including that of wildland fuels.
- Ecosystems have many kinds of organisms, which change over time and influence one another.
- Fire is an important natural process in many ecosystems.
- Native plants and animals have ways to survive and/or reproduce after fire.
- People influence the fire-dependent ecosystems where they live.

Meeting these goals helps implement the recommendation from the *Guidance for Implementation of Federal Wildland Fire Management Policy* (U.S. Dept. of the Interior and U.S. Dept. of Agriculture 2009) to transmit a clear message about the important role of fire as a natural process.

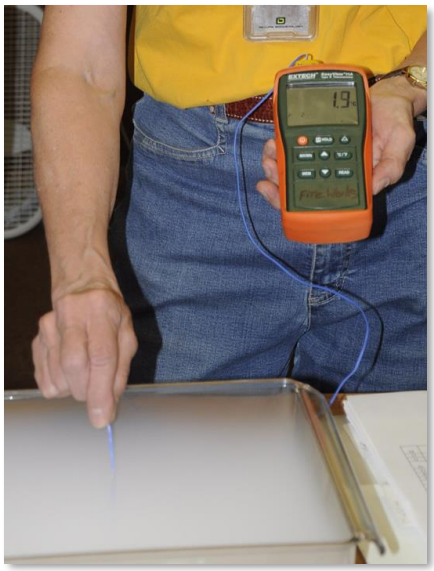
Why *FireWorks*?

FireWorks provides students with interactive, hands-on materials to study the forces that cause change, an integral part of healthy, enduring ecosystems in most temperate regions of the world. Based on the science of wildland fire, a highly interdisciplinary field, it provides a context for learning about:

- properties of matter
- chemical and physical processes
- ecosystem fluctuations and cycles
- habitat and survival, and
- human interactions with ecosystems.

FireWorks also 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 verbally and in writing
- identifying and expressing responses to science-related questions
- working in teams to solve problems and
- critical listening and reading.



Students using *FireWorks* ask questions, gather information, analyze and interpret data, 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).

The concepts and skills listed above are important in the Next Generation Science Standards (NGSS) and other state standards, including Idaho's new science standards which are based on the NGSS standards. These skills are crucial for developing an adult citizenry literate in science and attracting students to professional work in the sciences.

Lesson Plan Format

Each lesson has the following sections:

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

Subjects: Science, Writing, Speaking & Listening, Art

Duration: 30 - 50 minutes

Setting: Laboratory or outdoors

Vocabulary

- ecosystem
- ecological community
- fire behavior

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		Middle School (Grades 6-8)
NGSS	**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
Common Core ELA	**Writing**	4, 7, 10
	Speaking & Listening	1, 2, 4, 6
	Language Standards	1, 2, 3, 6
	Writing Standards Science & Technical Subjects	4, 7, 10
EEEGL	**Strand 1**	A, B, C, E, F, G

***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 particular 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 safely 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 work space 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 Sagebrush 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 sagebrush ecosystem located close to many students throughout the West, a vast and diverse area containing 350+ species.

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.

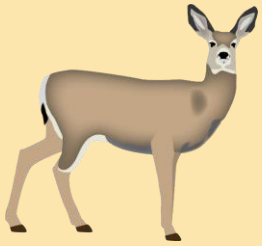
The table below lists historic fire regimes by group. Sagebrush steppe has historically been in Group 4.

Historic Fire Regimes				
Group	**Frequency**	**Severity**	**Description**	**Example**
Group 1 Frequent, low severity fires	0 – 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

The **high desert floor** is characterized by big sagebrush, low sagebrush, and salt-desert shrub systems. With increasing elevation, the higher plateaus and rocky areas support western juniper and curlleaf mountain mahogany communities. Aspen communities grow along streams and drainages in the mountain gorges and riparian zones, providing an important source of forage for deer and other wildlife. The **subalpine zone** supports low-growing shrubs, grasses, and wildflowers such as white mountain avens. Isolated stands of Douglas-fir and whitebark pine also occur in the mountains.

Wildlife species of concern include greater sage-grouse, mule deer, elk, pronghorn, pygmy rabbit, snowshoe hare, and golden eagle. Important habitats in the ecoregion include migration corridors and areas for overwintering pronghorn, as well as seasonal habitats for greater sage-grouse. Human-influenced changes in the ecoregion have affected fire frequency, severity, and seasonality. Additional effects are expected in the future from climate change influences, as well as a new awareness of allowing fires to burn, utilizing controlled burns, and new sources of ignition (e.g., more people moving into the Wildland Urban Interface).

The presence of **invasive species**, especially **cheatgrass**, in the ecoregion has made fire more problematic. In the sagebrush ecosystem areas, the primary woody species are not fire-adapted or fire-dependent. In the most dry, fuel-limited systems, fire may have almost never occurred. In other areas, fire may have occasionally burned these ecosystems (e.g., every few hundred years or more on average), especially after periods of significantly above-average moisture that may have increased fuel loads.

Summary of Sagebrush Ecosystem Ecology	
Sample Wildlife 	Greater sage-grouse, burrowing owl, pronghorn antelope, coyote, harvester ants, mule deer, golden eagle, pygmy rabbit, ferruginous hawk, American badger, sage sparrow, and prairie rattlesnake
Sample Plants 	Sagebrush, arrowleaf balsamroot, bluebunch wheatgrass, Idaho fescue, juniper, Indian paintbrush, Great Basin wild rye, bitterbrush, rabbitbrush, penstemon, tapertip hawk's beard, western yarrow, and wild onion
Sample Disturbances 	Invasive and noxious weeds (especially cheatgrass and medusahead), fire, fragmentation of the ecosystem (especially from roads and other development), and infrastructure associated with energy development
Traditional Native American Uses of Sagebrush 	Tea made from various parts of the plants and used extensively in medicine, for example to treat wounds and sore throats because of its antiseptic properties; wood used as fuel; stringy bark used to make ropes and baskets

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