Burning Issues: Fire in Wildhorse Basin

Interactive Media Science Project
Florida State University
Tallahassee, Florida

United States Department of Interior
Bureau of Land Management
Cheyenne, Wyoming

ABOUT WILDHORSE BASIN

This material is based on work supported by the Wyoming State Office of the Bureau of Land Management, Department of the Interior. Any opinions, findings, and conclusions or recommendations are those of the authors and do not necessarily reflect the views of the supporting agency.

Burning Issues: Fire in Wildhorse Basin is a joint effort of Florida State University's Interactive Media Science Project and the Bureau of Land Management, Cheyenne, Wyoming.

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EDUCATOR'S GUIDE TO THE WILDHORSE BASIN WEBSITE

Welcome to the **Wildhorse Basin** Website! These web-based instructional materials help students use **inquiry** to learn about the critical role fire plays in ecosystem management. The on-line activities called ***EcoVentures,*** are specifically designed to increase understanding about the sage-steppe habitat found in the western United States.

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The Wildhorse Basin website has six inter-related components.

1. The **Introduction** has short video clips that answer many of the commonly asked questions about fire and the history Wildhorse Basin.
2. The **Biodiversity** section contains an illustrated field guide describing some of the plants and animals found in this ecosystem.
3. The **Fire and Mule Deer *EcoVenture*** helps students discover the relationship between fire and mule deer populations.
4. The **Rx Fire in Sage *EcoVenture*** encourages students to decide if and when to set a prescribed fire to improve sage grouse habitat.
5. The **Rehab *EcoVenture*** evaluates different strategies for restoring a population of Colorado River Cutthroat trout after a wildland fire destroys most of the watershed.
6. The **Flames *EcoVenture*** challenges students to use the techniques they have learned to either suppress a wildland fire or allow it to burn.

The **Student Handouts** found at the end of this **Educator's Guide** are an important part of this program. They guide students through the ***EcoVentures*** and will help you assess student learning. The "Who Am I" questionnaire helps students discover and learn about the organisms found in Wildhorse Basin. The BLM Mule Deer Census Form helps students gather and organize the data they collect during the Fire and Mule Deer ***EcoVenture***. The Prescribed Fire Plan helps students through the Rx in Sage ***EcoVenture*** and gives them the opportunity to reflect on the choices they made and why they made those choices. Tables in both Flames and Rehab guide students through the ***EcoVentures*** and help them formulate evidence-based conclusions.

Vocabulary: biodiversity, Burned Area Emergency Rehabilitation (BAER), carrying capacity, density, diversion, forage, forb, habitats, lek, predators, prescribed burn, reservoirs, sediment, treatment, whirling disease, wildland fire

Student Learning Objectives

* Identify and describe the organisms commonly found in the sagebrush-juniper ecosystem.
* Recognize wildland fire as a natural process.
* Discuss the role fire plays in the sagebrush-juniper ecosystem
* Describe the benefits of prescribed burning.
* Describe the problems associated with prescribed burning.
* Gather and analyze data on mule deer populations.
* Explain how wildland fire affects sage grouse.
* Describe how to use fire fighting equipment to monitor or suppress a wildland fire.
* Assess different rehabilitation strategies for stream habitats after a wildland fire.

Visit the ***Burning Issues*** website to learn about our DVD program that features a variety of fire-prone ecosystems. To obtain copies of the DVD ***Burning Issues II,*** visit www.eea.freac.fsu.edu and click on the **Materials** section.

This site helps students attain these national standards:

Science Standards

Unifying Concepts & Processes

* Evidence, models & explanation
* Change, constancy & measurement
* Evolution & equilibrium
* Form & function

Science as Inquiry

* Abilities necessary to do scientific inquiry
* Understanding scientific inquiry

Life Science

* Characteristics of organisms
* Life cycles of organisms
* Organisms and the environment

Science and Technology

* Ability of technological design
* Understanding science and technology
* Ability to distinguish between natural objects and objects made by humans

Science in Personal & Social Perspectives

* Characteristics & changes in populations
* Types of resources
* Changes in environments
* Science & technology in local challenges

History & Nature of Science

* Science as a human endeavor

Technology Standards

Basic operations and concepts

* Students are proficient in the use of technology.

Social, ethical and human issues

* Students understand the ethical, cultural and societal issues related to technology.
* Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits and productivity.

Technology productivity tools

* Students use technology tools to enhance learning, increase productivity, and promote creativity.
* Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications and produce other creative works.

Technology communications tools

* Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.

Technology research tools

* Students use technology to locate, evaluate, and collect information from a variety of sources.
* Students use technology tools to process data and report results.

Technology problem-solving and decision-making tools

* Students use technology resources for solving problems and making informed decisions.
* Students employ technology in the development of strategies for solving problems in the real world

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Answers for Student Handouts

Who Am I?

Scroll around the panorama of Wildhorse Basin and identify the organisms you find there.

1. Fire helps the populations of my favorite prey, deer. *Mountain lion*
2. Introduced fish have jeopardized my future. *Colorado River cutthroat trout*
3. My scientific name means "little bell." *Midget faded rattlesnake*
4. My wood is decay-resistant and is used as fence posts. *Utah juniper*
5. I grow in bunches and my seeds look like rice. *Indian ricegrass*
6. I am a tree found along the banks of rivers and streams. *Yellow willow*
7. My thorny branches are covered with thick, narrow, fleshy leaves. *Greasewood*
8. Pronghorns depend on this nutritious shrub that names this habitat. *Sagebrush*
9. My long ears and white tail make me easy to identify. *Whitetail jackrabbit*
10. When it gets too hot, I hibernate. *Ground squirrel*
11. I am found throughout North America. *Coyote*
12. As an introduced mammal, I am prized by some people and hated by others. *Mustang (wild horse)*
13. I am a bird that never digs so my name is all wrong. *Burrowing owl*
14. My featherless head is pink or even red. *Turkey vulture*
15. I am a bird that is easily tamed and often beg for food. *Raven*
16. My big ears are responsible for my name. *Mule deer*
17. I catch my prey by digging them out of the ground. *Badger*
18. I have horns and I'm the fastest mammal in the United States. *Pronghorn*
19. I'm a food source for just about every predator. *Desert cottontail*
20. I'm a short-tailed cat with an expanding range. *Bobcat*
21. I soar with my wings parallel to the ground. *Golden eagle*
22. I am found almost exclusively in a habitat that bears my name. *Sage-grouse*
23. My tail's color gives you my name. *Red-tailed hawk*
24. I am often found in a herd and cause some ranchers concern. *Elk*

Fire and Mule Deer *EcoVenture*

1. Calculate the **carrying capacity** of the study area. Carrying capacity is the largest population the resources in an area can support without damaging the environment. Carrying capacity is usually given as a **density** (number per square kilometer). The survey area was 20 km long and the scanner covered a width of 2 km. How many square km were surveyed? *40 km^2*

2. Use the data for Year 1 and Year 2 to calculate the carrying capacity of this part of Wildhorse Basin. Hint: (count for year 1 + count for year 2)/ 2 = average count. Average count divided by area = density. *Carrying capacity = 2.5 deer/km^2*

3. In Year 3, the Bureau of Land Management did a **prescribed burn** that included about 12 square km in sections 3 to 9 of the study area. How did this treatment affect the deer population? *The deer appear to have moved out of the treatment area and into the adjacent unburned sections.*

4. How did this burn affect the total deer population? *The total population remained about the same.*

5. What happened to the deer populations in the unburned areas? *Deer populations in the sections near the prescribed burn increased; in the sections farther away from the prescribed burn, the populations remained the same.*

6. In Year 4 of the study, a **wildland fire** swept through the western end of the study area burning about 16 km^2. What effect did the wildland fire have on the total deer population? *Total population decreased significantly. The deer either died in the fire or moved away from the survey area.*

7. How do you account for the very low counts in sections 12 to 20 for Years 4, 5, and 6? *The wildfire went through this section of the study area in Year 4 and destroyed the deer's habitat. The deer did not return to the area until Year 7 and then only a few returned.*

8. Based on the data you collected, when do you think the deer population in the wildfire area will return to carrying capacity? *Prior to the wildfire, the average population for this area was about 44.6 deer so the carrying capacity for this area was about 2.8 deer/km^2. Four years after the fire, the population of this area had increased to 19 deer or 1.2 deer/km^2. At this rate it will take about 4 more years for the population to reach carrying capacity.*

9. Compare the recovery rate of the deer population in the prescribed fire sections with the recovery rate of the deer population in the sections that had the wildland fire. *The deer populations in the area of the prescribed burn recovered the next year and were a bit higher than normal the second year. The deer in the area that had the wildland fire had only partly recovered after four years.*

10. Why are the effects from the prescribed fire different than the effects of the wildfire? *The wildfire was much hotter and destroyed most of the vegetation that mule deer need for browse and cover. The prescribe fire burned cooler and only killed a few plants and the deer were back the next year.*

Prescribed Fire Plan
For
Wildhorse Basin, Wyoming
Rock Spring Field Office
Bureau of Land Management

Prepared by: ***Bernie L. Moore*** Date_____
BLM Zone Fire Ecologist

Assisted by: _____Date_____

Approved by: _____ Date _____

Management Summary

This prescribed fire project will enhance sage grouse use of a lek that has been taken over by sagebrush and juniper. The lek is located on the Currant Creek drainage area within Wildhorse Basin. The fire will improve habitat by increasing grasses and forbs, providing different age classes and heights of sagebrush, and removing the junipers.

This prescribed burn is rated as a "Low Complexity" burn per BLM Guidelines. The proposed burn project area is small (< 2.0 km^2) and there are no cultural sites within the area. The most important aspects of this burn are the timing of the start of the fire (ignition) and providing fuel breaks to reduce the potential of the fire escaping.

Resource Management Objectives

* Reduce the cover of sagebrush and juniper by 75 percent on the lek.

* Reduce the cover of juniper by 75 percent on the entire project area.

* Provide a mosaic of openings in the remaining sagebrush habitat that have few to no juniper, maintain at least 70 percent of the sagebrush habitat.

* Provide the opportunity to enhance biodiversity by increasing the native grass and the forb understory.

* Increase the number of sage grouse that use the area as a lek.

Prescribed Fire Plan

Fire Prescription

Complete the Prescribed Fire Plan using data from the **Rx Fire in Sage *EcoVenture***.

Which season will give you the best burn?

Season *fall*

Now that you have selected the best season to burn, what combination of other environmental factors will give you the best results? Click on the pictures of tools to learn how each environmental variable plays an important role in deciding when to burn. What is the best mix for each of these variables? After you have checked out the tools, move the sliders to adjust the settings. Record your settings in the table. Then click on the **Light the Fire!** button and describe your results.

Trial 1

Environmental Variables	Low	Medium	High
Wind Speed	**X**	**X**	
Relative Humidity	**X**	**X**	
Fine Fuel Moisture		**X**	
Live Fuel Moisture	**X**		

Results: *The best settings are a low or medium wind, low or medium relative humidity, medium fine fuel moisture, and low live fuel moisture. Answers may vary slightly.*

Trial 2

Environmental Variables	Low	Medium	High
Wind Speed			
Relative Humidity			
Fine Fuel Moisture			
Live Fuel Moisture			

Results: _____

_____

Trial 3

Environmental Variables	Low	Medium	High
Wind Speed			
Relative Humidity			
Fine Fuel Moisture			
Live Fuel Moisture			

Results: _____

_____

After you have completed the **Rx Fire in Sage *EcoVenture,*** answer these questions and complete the activities.

1. What are some factors resource managers need to consider for conducting a prescribed burn? *Time or season of the year, wind speed, fuel moisture and relative humidity are all important. Other factors might be the amount of fuel available (fuel load), slope of the land, presence of any cultural features, and how close the area is to private property.*

2. Why is the time of the year (season) an important consideration? *Sage grouse are ground nesters and chicks might be caught in a burn so understanding the life cycle of the sage grouse is an important consideration in choosing the best season to burn.*

3. Why is it important to keep leks clear of encroaching woody vegetation? *Sage grouse require open areas for courtship and attracting mates. Woody vegetation that encroaches on the lek decreases its usefulness to the grouse.*

4. Explain the role of the environmental variables (wind speed, relative humidity, fine fuel moisture and live fuel moisture) when conducting a prescribed burn. *You should not burn when the winds are high because the fire might get away and become a wildland fire. Relative humidity is important in determining how slow or how fast a fire will burn. Fine fuel that is too dry will burn rapidly and the fire may escape. Live fuel that is too moist will not burn well nor will it carry the fire.*

5. What are some of the problems associated with prescribed burns? *Winds may increase in speed or change direction putting property and/or people in danger. The fuel loads may be too high and need to be reduced by mechanical means prior to the burn.*

6. What are some of the benefits of prescribed burns? *Prescribed burns are a relatively quick and inexpensive way of reducing fuel loads and reducing the probability of dangerous wildland fires. Most species of native wildlife are adapted to a natural fire regime.*

7. Teams of resource managers with different areas of expertise put prescribed burn plans together. Why do you think it is important for a team to do this? *Everybody can add to the plan based on their area of expertise and experience. This will create a better plan than if a single person develops it.*

Rehab *EcoVenture*

As you use each Tool, record its cost. Record the number of fish observed at each sampling site for each year. Calculate the total for each year. **To get accurate counts, place the shocking Tool's hoop on the sampling point.**

Teacher's note: Each Tool has its own random number generator so results will vary. These answers are only examples.

Table 1. Shocking Results

SAMPLING SPOT	A	B	C	D	E	F	BASELINE TOTAL
BASELINE	***15***	***13***	***12***	***9***	***14***	***10***	***73***

Table 1 a. Plant willows

SAMPLING SPOT	A	B	C	D	E	F	YEARLY TOTAL
Year 1	***4***	***4***	***2***	***4***	***3***	***3***	***20***
Year 2	***7***	***5***	***3***	***3***	***7***	***6***	***31***
Year 3	***7***	***4***	***4***	***3***	***5***	***3***	***26***
Year 4	***6***	***7***	***5***	***3***	***6***	***7***	***34***

1. What was the cost for planting willows? *$2,000*

2. How efficient was planting willows to provide shade and reduce stream bank erosion? (Hint: Divide the cost of planting willows by the number of fish counted in Year 4. Round off to the nearest whole number)

$ _____ per fish

Answers will vary but should be about $59

3. What are some additional reasons planting willows is a good rehab strategy? *Trees provide habitat for birds, deer and other animals.*

Table 1 b. Silt dike

SAMPLING SPOT	A	B	C	D	E	F	YEARLY TOTAL
Year 1	***5***	***4***	***3***	***2***	***2***	***4***	***20***
Year 2	***7***	***6***	***6***	***5***	***6***	***5***	***35***
Year 3	***10***	***9***	***7***	***6***	***9***	***7***	***48***
Year 4	***8***	***8***	***9***	***7***	***9***	***8***	***49***

4. What was the cost for installing the silt dike? $*10,000*

5. How efficient was the silt dike in reducing stream bank erosion? $_____ per fish

Answers will vary but should be about $204

6. What are some additional reasons for installing a silt dike? *Plants will grow in the soil that builds up behind the silt dike and provide habitat of a variety of wildlife.*

Table 1 c. Grade control structures

SAMPLING SPOT	A	B	C	D	E	F	YEARLY TOTAL
Year 1	***3***	***2***	***2***	***4***	***4***	***1***	***16***
Year 2	***12***	***8***	***9***	***5***	***8***	***8***	***50***
Year 3	***11***	***11***	***10***	***9***	***10***	***7***	***58***
Year 4	***14***	***13***	***12***	***7***	***14***	***10***	***70***

7. What was the cost to install grade control structures? $*180,000*

8. How efficient was installing grade control structures? $_____ per fish

Answers will vary but should be about $2,570

9. What are some additional reasons for installing grade control structures? *Grade control structures will enhance wildlife habitat by creating small marshes behind them, ,retain some water during periods of drought and help control flooding during periods of high water.*

Table 1 d. Soil netting

SAMPLING SPOT	A	B	C	D	E	F	YEARLY TOTAL
Year 1	***2***	***5***	***4***	***1***	***3***	***3***	***18***
Year 2	***6***	***8***	***5***	***5***	***8***	***5***	***35***
Year 3	***9***	***9***	***5***	***5***	***7***	***7***	***42***
Year 4	***9***	***8***	***9***	***8***	***8***	***6***	***48***

10. What was the cost to install soil netting? *$6,000*

11. How efficient was installing soil netting to reduce stream bank erosion? $_____ per fish *Answers will vary but should be about $125*

12. What are some additional reasons to install soil netting? *Soil netting prevents soil from getting in the water and helps plants get established in the area where it is put down. These plants stabilize the soil and provide habitat for wildlife.*

Table 1 e. Remove cattle

SAMPLING SPOT	A	B	C	D	E	F	YEARLY TOTAL
Year 1	***4***	***4***	***3***	***3***	***3***	***2***	***19***
Year 2	***5***	***3***	***5***	***2***	***5***	***5***	***26***
Year 3	***6***	***4***	***4***	***4***	***8***	***6***	***32***
Year 4	***6***	***6***	***5***	***3***	***6***	***5***	***31***

13. What was the cost of removing cattle? $*none*

14. How efficient was removing the cattle to reduce stream bank erosion and water pollution? $_____/fish *Answers will vary. Since there were no dollars invested and cattle can be removed by administrative action, this is a very efficient way to enhance the fishery.*

15. What are some additional reasons for removing cattle after a wildland fire? *Removing cattle stops manure from getting into the stream's water thus preventing pollution in an already stressed aquatic ecosystem. In addition, the vegetation on the slopes around the stream will recover more*

quickly if the cattle are removed. This will benefit the stream as well as other forms of wildlife that live in the area.

16. What combination of Tools do you think will be most efficient? Write your hypothesis and reasons why these techniques were chosen here.
Answers will vary but students should provide a reasonable justification for their hypothesis.

To install more than one RehabTool, click on your choice of tools. You can click on one, two or more.

17. Based on the results from your simulation, was your hypothesis correct? Write your conclusion based on the simulation. _____

_____

After you have completed all the parts of Table 1 (a. through e.), answer the following questions about rehab strategies after a wildland fire.

18. Explain why installing grade control structures might not be the best strategy for rehabbing Currant Creek. *Installing grade control structures is the most expensive option and has the lowest efficiency. It also changes the habitat of the aquatic ecosystem from a free-flowing stream to one that is partially dammed up. This change in habitat may be better for some of the trout species that compete with the CRCT.*

19. What single rehab Tool was the most effective in restoring the population density of Colorado River cutthroat trout? *Answers may vary because data is randomly assigned to the different treatments (Tools). Students should be able to justify their answers based on the data they collected.*

20. What Tool was the least effective? *Answers may vary because data is randomly assigned to the different treatments (Tools). Students should be able to justify their answers based on the data they collected.*

21. Rank the Tools in terms of efficiency as measured by the costs per fish. If you had limited funds, what Tool or combination of Tools would you recommend be used to rehab this area? *Answers will vary but should start with the most efficient Tool (removing cattle) and end with the least efficient (installing grade control structure).*

EcoChallenge
Use the data you collected over the 4 years to predict when the density of Colorado River cutthroat trout will be restored to its pre-fire (baseline) density. What are some factors that might prevent this from happening? *Based on the growth rates observed during the 4 years data was collected, students should predict the population should reach pre-fire densities in 6 to 8 years. Some factors that might prevent this from happening include another wildland fire, re-introduction of cattle before the vegetation is restored, weather-related events (drought/flooding) and a change of management plans for the area.*

Extension
How would a rehab plan for a warm-water fishery such as the one found in Flaming Gorge Reservoir differ from a rehab plan for Colorado River cutthroat trout? Use the web and other references to identify their similarities and differences.

From the data in Table 1, construct graphs to compare the costs, hectares burned and the elapsed time for several ***Flames*** lessons.

1. Write a paragraph describing the firefighting resources used and why they were called up for each fire. What wildland fire strategy did your team use; management for the natural benefits or aggressive suppression of the fire? Support your decision to let it burn or to suppress it. Did you have injuries? How did they occur?
Answers will vary but should identify the different fire fighting resources such as hotshot crews, aircraft, dozers and justification for their use. Students should justify their decisions based on the costs, location, and safety issues.

2. Compare and contrast the costs and benefits of each resource.
The helicopter and air tankers are expensive firefighting resources but they can attack a fire much faster than hotshot crews, dozers or fire trucks. An air attack minimizes risk to firefighters and impacts to the environment. The dozer is cheap and builds lines fast but has a severe impact on the ecosystem. The tanker truck is somewhat slower than the dozer, but presents much less impact to the ecosystem. The hotshot crew is cost effective and has minimal ecosystem impact but is much slower and easily threatened by a fast moving fire.

3. In a ***Flames*** lesson of your choice, rank your choice of resources according to the fastest suppression time and lowest cost.
The dozer and hotshot crews are the best choices.

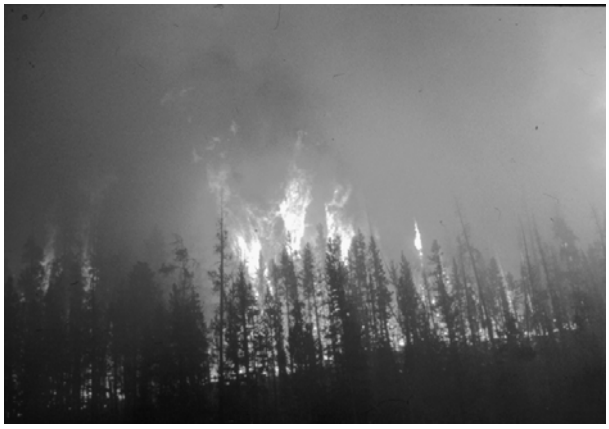
4. Describe a general plan to manage a wildland if your budget was limited. What equipment and human resources would you use? How would you measure success?
Release expensive resources such as aircraft; construct fire lines some distance from fire tying them to natural barriers such as water and/or rock; release crews when the fire is surrounded and let it burn within constructed fire breaks.

5. Your team is in charge of a "challenging" wildland fire. Use the ***Flames*** simulation to identify the firefighting resources you can use to suppress this fire in 24 hours (or less). Justify your choices. Were you able to provide for the safety of your people?
Strategies should include safety of dozer and hotshots; using natural fuel breaks (water/rock) when locating fire lines, use of aircraft in front of fire rather than people.

BACKGROUND MATERIALS

STUDENT HANDOUTS

The Role of Fire in Ecosystem Management



Fire is an ecological component of many ecosystems. People have manipulated fire for various reasons over the course of human history. Fires, deliberately set by Native Americans, created the landscapes early European settlers first encountered in North America. To sustain these natural ecosystems, today's land managers must maintain or restore historic fire regimes. Fire is an ecosystem process as well as a tool for managing natural resources. Excluding wildland fires from an ecosystem allows dead plant material and dense understory plants to build up, providing the fuel that allows fires to burn with more intensity. After years of exclusion, wildland fires can devastate the ecosystems.

Unlike wildland fires, prescribed fires are used only when conditions such as fuel moisture, humidity, and wind speed are right and the intensity and location of the fire can be controlled. In some places these carefully planned fires are used to remove diseased trees or to selectively maintain certain plants species such as longleaf pine.

A naturally ignited fire (as well as human-caused fires) presents land managers with a choice: suppress them or allow them to burn under predetermined conditions. The decision is based on many considerations including conforming to environmental laws (i.e. Clean Air Act); the need to protect certain habitats, human life, or property; the presence of important archaeological or historic sites; and whether the historic fire regime has previously been disrupted. In many areas, fire has been excluded for the past 75 to 100 years allowing natural fuels to increase. The result is today's fires are more frequent, burn more intensely, and are more dangerous. Land managers must carefully weigh their decision of managing fires now against the future probability of increased fire intensity due to fire exclusion.

A disrupted fire regime has far-reaching effects on ecosystems. For example, after wildland fires, noxious weeds can invade a burned area and displace the native plants. In many places, people have built homes and even whole communities in ecosystems that burn regularly, placing themselves and their property at risk. Land managers must balance the needs of people and ecosystems.

Fire management is a complex issue with many factors that need to be considered. Fire can be a positive tool in maintaining healthy ecosystems. This website is designed to make young people aware of the problems and issues associated with wildland fires and what they can do to make a difference in keeping ecosystems healthy.

For more information about wildland fires and fire ecology, visit the National Interagency Fire Center (www.nifc.gov) and the Bureau of Land Management's Environmental Education website (www.blm.gov/education).

Who Am I?

Scroll around the panorama of Wildhorse Basin and identify the organisms you find there.

1. Fire helps the populations of my favorite prey, deer. _____
2. Introduced fish have jeopardized my future. _____
3. My scientific name means “little bell.” _____
4. My wood is decay-resistant and is used as fence posts. _____
5. I grow in bunches and my seeds look like rice. _____
6. I am a tree found along the banks of rivers and streams. _____
7. My thorny branches are covered with thick, narrow, fleshy leaves. _____
8. Pronghorns depend on this nutritious shrub that names this habitat. _____
9. My long ears and white tail make me easy to identify. _____
10.
11. When it gets too hot, I hibernate. _____
12. I am found throughout North America. _____
12. As an introduced mammal, I am prized by some people and hated by others. _____
13. I am a bird that never digs so my name is all wrong. _____
14. My featherless head is pink or even red. _____
15. I am a bird that is easily tamed and often beg for food. _____
16. My big ears are responsible for my name. _____
17. I catch my prey by digging them out of the ground. _____
18. I have horns and I’m the fastest mammal in the United States. _____
19. I’m a food source for just about every predator. _____
20. I’m a short-tailed cat with an expanding range. _____
21. I soar with my wings parallel to the ground. _____
22. I am found almost exclusively in a habitat that bears my name. _____
23. My tail’s color gives you my name. _____
24. I am often found in a herd and cause some ranchers concern. _____

Fire and Mule Deer *EcoVenture*

Introduction

Mule deer are named for their large mule-like ears. They also have a large white rump patch

and a small, drooped, rope-like tail tipped in black. They are often called black-tailed deer or burro deer. Scientists recognize nine subspecies. Mule deer don't run; they have a peculiar and distinctive bouncing leap that can cover distances up to 8 m. When they land, all 4 feet hit the ground together. Mule deer can reach speeds of 72 km/h for short periods. The males are longer than the females (1.7 m vs. 1.6 m) and heavier (120 kg vs. 80 kg). They inhabit the entire western United States, north to Alaska and south to Mexico and the Baja.

Mule Deer Life History

Mule deer prefer mixed **habitats** with woody cover for protection from wind and temperature extremes and nearby open areas for feeding. Deer are most active morning and evenings and usually bed in heavy cover during the day.

Breeding occurs in the fall and one or two fawns are born in early summer after a gestation period of seven months. Fawns weight about 3.5 kg, have spotted coats, and remain hidden for their first week of life. Fawns are weaned and lose their spots when they are about 4 months old and stay with the doe for their first year. A yearling buck usually has two points on each antler in the form of a "Y."

Antlers grow with a velvety covering of skin that provides nourishment. In late summer, hormonal changes end the growing process and the antlers harden to a bone-like consistency. The velvet skin dries and the bucks remove it by rubbing their antlers on brush and small trees. Antlers remain hard and polished until they are shed in late winter.

Mountain lions and wolves are **predators** of adult mule deer. Bobcats, coyotes, and eagles have been observed killing and eating fawns.

Mule deer are browsers and eat a variety of plants. The best mule deer **diet** includes new growth because of its high nutrition and low fiber content. Grasses and forbs are important spring and summer foods. Deer are also fond of mushrooms and the vines of grapes and berries. During the fall and winter they browse shrubs and the low branches of trees for twigs and leaf buds. Acorns are a rich and favored food in areas where oaks are present.

Fires that create mosaics of forage areas and dense cover benefit mule deer. These deer seem to prefer foraging in burned areas more than unburned areas. This preference may indicate an increase in plant nutrients which usually occurs following fires. Scientists have discovered that deer seem to select the most nutritious vegetation available. Fire enhances the growth of new grasses in grassland communities. Burning sagebrush communities can result in large increases of herbaceous plants by reducing the old, competing stands of sagebrush. In sagebrush communities, prescribed burns must be carefully planned to insure that enough cover remains after the fire burns out.

Fire & Mule Deer *EcoVenture*

What You Will Do

In this ***EcoVenture*** you will investigate the effects of prescribed fire and wildland fire on mule deer in Wildhorse Basin. To count the deer, you will take a simulated flight from Durham Ranch to Jane's Road following Currant Creek. The flight is 20 kilometers (km) long. At the end of each kilometer you will need to record the number of deer you see during the flight on the **BLM Mule Deer Census form**.

To gather enough data to make inferences about the effects of fire on the deer herd, you will need to make the flight 8 times representing an 8-year period. All the flights take place in early June. After you have gathered your data, answer the questions about fire and mule deer.

Why It's Important

Fire is an important part of the sagebrush-juniper ecosystem and mule deer make extensive use of this habitat. Land managers need to know how wildfire and prescribed fires effect mule deer populations. Do fires have a positive effect? Do they have a negative effect?

Ready? Begin

If you are not familiar with the plants and animals found in the sagebrush-juniper ecosystem, take an on-line tour of the area by clicking on the **Biodiversity** button on the website. To get started with the ***EcoVenture***, click on the **Fire and Mule Deer** button. To learn more about your tasks, watch the **Intro Movie**. To begin the activity, click on the "**deer**."

EcoChallenge

Whitetail deer, elk and pronghorns also are found in the sagebrush-juniper ecosystem. How does wildland fire affect their populations? Do you think their response is the same as mule deer? Choose a species and use the web and other resources to investigate how fire affects these large mammals.

Extension

Suppose you are a member of a BAER team creating a recovery plan for Wildhorse Basin after a huge wildland fire. What are some "action items" you would recommend to help the ecosystem recover as soon as possible?

After completing the **Fire and Mule Deer *EcoVenture***, use the data you collected to answer the following questions:

1. Calculate the **carrying capacity** of the study area. Carrying capacity is the largest population the resources in an area can support without damaging the environment. Carrying capacity is usually given as a **density** (number of organisms per square km). The survey area was 20 km long and the scanner covered a width of 2 km. How many square kilometers were surveyed? _____ km^2

2. Use the data for Year 1 and Year 2 to calculate the carrying capacity of this part of Wildhorse Basin. Hint : (count for year 1 + count for year 2) / 2 = average count. Average count divided by area = density.

_____

3. In Year 3, the Bureau of Land Management did a **prescribed burn** that included about 12 km^2 in sections 3 to 9 of the study area. How did this treatment affect the deer population?

_____

_____

4. How did this burn affect the total deer population? _____

5. What happened to the deer populations in the unburned areas? _____

_____

6. In Year 4 of the study, a **wildland fire** swept through the western end of the study area burning about 16 km^2. What effect did the wildland fire have on the total deer population? _____

_____

7. How do you account for the very low counts in sections 12 to 20 for Years 4, 5, and 6? _____

_____

_____

8. Based on the data you collected, when do you think the deer population in the wildfire area will return to carrying capacity? _____

_____

_____

9. Compare the recovery rate of the deer population in the prescribed fire sections with the recovery rate of the deer population in the sections that had the wildland fire. _____

_____

10. Why are the effects from the prescribed fire different than the effects of the wildfire? _____

_____

BLM Mule Deer Census

Wildhorse Basin/ Current Creek Study

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	***Site Total***
Site 0-1									
Site 1-2									
Site 2-3									
Site 3-4									
Site 4-5									
Site 5-6									
Site 6-7									
Site 7-8									
Site 8-9									
Site 9-10									
Site 10-11									
Site 11-12									
Site 12-13									
Site 13-14									
Site 14-15									
Site 15-16									
Site 16-17									
Site 17-18									
Site 18-19									
Site 19-20									
Total count									

Rx Fire in Sage *EcoVenture*

Introduction

The western United States has about 38 million hectares of land dominated by various sagebrush species. In Wyoming, about 14 million hectares are covered by 13 different species of sagebrush. As these communities evolved, differences in soils and climates led to changes in wildland fire frequency and intensity. The historic sagebrush-steppe ecosystem was a mosaic of different communities created and maintained by fire regimes ranging in frequency from 10 to 110 years. The diversity of the sagebrush community types provide habitat for 87 species of mammals and almost 300 species of birds. Industrial and residential development, fire suppression and over-grazing livestock have greatly changed this biotic community. One result has been a decline in sage grouse populations.

Sage Grouse Life History

Sage grouse require sagebrush to survive. Sage-brush is their principle food in the fall and winter and it is used as escape cover the rest of the year. Sage grouse avoid areas that have invading junipers because predators can ambush them.

Sage grouse court and attract mates on **leks** or strutting grounds. Leks are established in open areas surrounded by sagebrush. Leks are used year after year and are the center of year-round activity for resident sage grouse. Dense sagebrush stands adjacent to leks provide cover where sage grouse hide from predators. Leks are often found in old lake beds, openings on ridges, roads, landing strips, and burned areas. Sage grouse males use leks at sites near potential nesting habitat although some females have been known to nest 20 km from the nearest lek. Under certain conditions, plants encroach on these open areas and reduce their value as a breeding ground. When this occurs, a carefully planned prescribed fire may be used to open up the lek and restore its usefulness to sage grouse.

Productive sage grouse **nesting habitat** in Wyoming includes sagebrush stands containing sagebrush 28 to 60 cm tall and a canopy cover of at least 15 percent. The herbaceous understory should include at least a 7% grass canopy cover and a 6% forb canopy cover that is at least 18 cm tall. Ideally, these vegetative conditions should make up 80% of the sage grouse nesting habitat. Sage grouse nest in a shallow depression lined with grass and sage leaves beneath a sagebrush plant.

Early **brood rearing** generally occurs near the nest site. Hens with broods use sagebrush habitats with a 10% canopy cover, diverse vegetation, and an abundance of insects. Chick diets include forbs and invertebrates, especially ants and beetles. The diversity of plants seems to be directly related to the diversity of insects.

Radio tracking data indicate that **adult** sage grouse avoid dense, old-age stands of sagebrush that lack a diverse, productive understory of grass and forbs. During winter, sage grouse feed almost exclusively on sagebrush. Adult sage grouse prefer small openings within large areas of sagebrush that is of different heights and ages. Sage grouse avoid large open areas with less than 10% sagebrush cover.

Recent research in Wyoming indicates that sage grouse do not use areas for 20 years after they have been burned by wildfire. One way to reduce the impact of wildfire is to reduce the amount of accumulated fuels using carefully planned prescribed burns. When prescribed fire is used to improve sage grouse habitat, the burns should be no wider than 120 m. Sage grouse avoid areas where good cover is more than 60 m away.

Rx Fire is Sage *EcoVenture*

What You Will Do

In this ***EcoVenture*** you will be responsible for prescribing a fire to remove encroaching plants from the breeding grounds of **sage grouse**. These sites, or **leks,** may host more than a hundred birds. Junipers are invading this site, shading out the understory of forbs and grasses and reducing its value to sage grouse. Careful planning is needed before you make the prescribed burn. You will need to consider the season of the year and several abiotic factors. Fortunately the BLM's Zone Fire Ecologist has completed some parts of your Prescribed Fire Plan! Read over what's been done and complete the plan as you work through the ***EcoVenture***.

Why It's Important

Sage grouse are large, chicken-like birds. Their populations have been declining throughout their range because of habitat alteration, over grazing, and modification of the natural fire regime. Sage grouse are not endangered or threatened but are classified as a species of concern. Species of concern are organisms that may become threatened or endangered in the near future. Leks are an important part of sage grouse habitat because most breeding takes place during courtship. Leks must be carefully managed and many factors need to be considered before starting a prescribed burn.

Ready? Begin

If you are not familiar with the plants and animals found in the sagebrush-juniper ecosystem, take an on-line tour of the area by clicking on the **Biodiversity** button on the website. Click on the **Rx Fire in Sage** button and watch the **Rx Fire in Sage Movie**. To get started with the ***EcoVenture***, click on the sage grouse.

After you select the best time of the year to burn and the best combinations of environmental variables, record your results and answer the questions about prescribed fire in sagebrush.

EcoChallenge

This ***EcoVenture*** examines four abiotic (non-living) factors that help land managers determine if it is safe to set prescribed fires. What are some other factors or conditions that might have to be taken into consideration?

Extension

Prescribed burning improves the habitat for sage grouse and many other organisms. Write a report on ways prescribed fire can benefit the animals and plants that live in the sage-steppe ecosystem.

Prescribed Fire Plan
For
Wildhorse Basin, Wyoming
Rock Spring Field Office
Bureau of Land Management

Prepared by: ***Bernie L. Moore*** Date_____
BLM Zone Fire Ecologist

Assisted by: _____ Date_____

Approved by: _____ Date _____

Management Summary

This prescribed fire project will enhance sage grouse use of a lek that has been taken over by sagebrush and juniper. The lek is located on the Currant Creek drainage area within Wildhorse Basin. The fire will improve habitat by increasing grasses and forbs, providing different age classes and heights of sagebrush, and removing the growth of junipers.

This prescribed burn is rated as a "Low Complexity" burn per BLM Guidelines. The proposed burn project area is small (< 2.0 km^2) and there are no cultural sites within the area. The most important aspects of this burn are the timing of the start of the fire (ignition) and providing fuel breaks to reduce the potential of the fire escaping.

Resource Management Objectives

* Reduce the cover of sagebrush and juniper by 75 percent on the lek.

* Reduce the cover of juniper by 75 percent on the project area.

* Provide a mosaic of openings in the remaining sagebrush habitat that have few to no juniper, maintain at least 70 percent of the sagebrush habitat.

* Provide the opportunity to enhance biodiversity by increasing the native grass and the forb understory.

* Increase the number of sage grouse that use the area as a lek.

Prescribed Fire Plan

Fire Prescription

Complete the Prescribed Fire Plan using data from the **Rx Fire in Sage *EcoVenture***.

Which season will give you the best burn?

Season _____

Now that you have selected the best season to burn, what combination of other environmental factors will give you the best results? Click on the pictures of tools to learn how each environmental variable plays an important role in deciding when to burn. What is the best mix for each of these variables? After you have checked out the tools, move the sliders to adjust the settings. Record your settings in the table. Then click on the **Light the Fire!** button and describe your results.

Trial 1

Environmental Variables	Low	Medium	High
Wind Speed			
Relative Humidity			
Fine Fuel Moisture			
Live Fuel Moisture			

Results: _____

_____

Trial 2

Environmental Variables	Low	Medium	High
Wind Speed			
Relative Humidity			
Fine Fuel Moisture			
Live Fuel Moisture			

Results: _____

_____

Trial 3

Environmental Variables	Low	Medium	High
Wind Speed			
Relative Humidity			
Fine Fuel Moisture			
Live Fuel Moisture			

Results: _____

_____

After you have completed the **Rx Fire in Sage *EcoVenture*,** answer these questions and complete the activities.

1. What are some factors resource managers need to consider for conducting a prescribed burn? _____

_____

_____

2. Why is the time of the year (season) an important consideration? _____

_____

3. Why is it important to keep leks clear of encroaching woody vegetation? _____

_____

4. Explain the role of the environmental variables (wind speed, relative humidity, fine fuel moisture and live fuel moisture) when conducting a prescribed burn. _____

_____

5. What are some of the problems associated with prescribed burns? _____

_____

6. What are some of the benefits of prescribed burns? _____

_____

7. Teams of resource managers with different areas of expertise put prescribed burn plans together. Why do you think it is important for a team to do this?_____

_____

Colorado River Cutthroat Trout ReHab *EcoVenture*

Introduction
At least twelve species of native cutthroat trout inhabit the western United States. All of these animals require cold, clear, shaded streams with shallow pools and naturally fluctuating water levels. Most of the remaining populations of native cutthroat trout are found in Federally-protected wilderness and other roadless areas.

Colorado Cutthroat Trout Life History
One of these species, the Colorado River cutthroat trout (CRCT) (*Oncorhynchus clarki pleuriticus*) inhabits Currant Creek, part of our study area in Wildhorse Basin. The CRCT is the only native fish in the salmon family found in the basin. They are identified by their bright orange-to-red slash marks on both sides of the lower jaws. There are groups of large spots between the dorsal fin and their tails. Historically this species lived in much of the Colorado River drainage in Colorado, southern Wyoming and eastern Utah. Today, the CRCT is found only in 5% of its historic range. This limited distribution and other problems have caused biologists to carefully monitor the remaining populations and to take steps to improve the habitat.

Dozens of studies have shown reduced trout populations are related to habitat changes resulting from **grazing by livestock**. One Wyoming study found that when cattle were fenced out of the streamside, CRCT populations increased from 22 per kilometer to 275 per kilometer because of better stream-side cover, lower water temperatures and a decrease in sediment from erosion.

Diversion of water from natural streams and creeks has harmed CRCT populations throughout is historic range. This diverted water is used for agriculture or to supply water for people to consume. Several cutthroat populations are from each other because portions of the streams they occupy are blocked by water diversion devices.

This prevents the populations from exchanging genetic material and reduces their habitats. Dams and reservoirs also cause habitat destruction and population isolation.

Reservoirs are often stocked with non-native species of trout by fishers. These fish often hybridize with the native species such as the CRCT. Fortunately states have taken steps to prevent the illegal introduction of exotic species and are managing streams to protect the genetic purity of the core CRCT populations.

Introduction of non-native species of trout has also been linked to **whirling disease** in CRCT. *Myxobolus cerebralis* is a tiny parasite from Eurasia. It penetrates the head and developing bones of fingerling trout. The parasite multiplies very rapidly, putting pressure on the equilibrium organ causing infected fish to swim erratically (whirl). The young fish have trouble feeding and avoiding predators. In severe infections, the disease will kill most of the young-of-the-year fish. Those that survive until the cartilage hardens to bone can live a normal life span, but are marred by skeletal deformities. Fish can, however reproduce without passing on the parasite to their offspring.

Wildland fires often destroy CRCT streamside habitat causing water temperatures to increase. If the sage-juniper uplands are damaged, soil erosion from water and wind may cause sedimentation in the stream destroying valuable nesting habitat.

Rehab *EcoVenture*

What You Will Do

This ***EcoVenture*** will help you evaluate different techniques for rehabilitating (rehab) a section of Wildhorse Basin that has been damaged by a wildland fire. After the fire, sediment from the surrounding hills started to wash into Currant Creek. Fisheries biologists are concerned that species of fish, the Colorado River Cutthroat trout (CRCT) maybe eliminated from this portion of its range unless immediate actions are taken. CRCT are listed as a species of special concern and has been petitioned for federal listing under the Endangered Species Act.

Why It's Important

The Colorado River Cutthroat trout is an excellent indicator species that helps scientists determine the health of the Wildhorse Basin Watershed and especially the land that drains directly into Currant Creek. Populations of CRCT have been increasing since the implementation of the Currant Creek habitat improvement project. Fish density has increased from 5 per kilometers to as many as 300 per km. However the wildland fire that damaged portions of the watershed may greatly reduce or even eliminate CRCT from this important habitat. Over 2 km of Currant Creek burned to the water's edge. What are the effects of different Tools used to rehab the watershed surrounding a critical habitat such as Currant Creek? What rehab strategy is most effective? Is there a combination of Tools that seem to be the "best management practice?"

Ready? Begin

After you have checked out the ***EcoVenture***'s Intro Movie, click on the Tools to learn about the different techniques biologists use to re-rehab a site after a damaging wildland fire. Which Tools do you think will be most effective?

Before you begin applying the Tools, you will need to gather baseline data. These data will let you know how many CRCT this habitat supported before the fire. Use Table 1 to record the data you get when you move the "Shocker" icon from sampling site to sampling site. After you have recorded all the baseline data, start using the Tools.

To determine which Tools are most effective, you will have to try them over a 4-year period. Record the data for each Tool in the correct part of Table 1.

After you have evaluated the effectiveness of each individual Tool, you can try a combination of Tools by clicking on your choice to add additional Tools**.** Click on the tool again to de-select it.

EcoChallenge

Use the data you collected over the 4 years to predict when the density of Colorado River cutthroat trout will be restored to its pre-fire (baseline) density. What are some factors that might prevent this from happening?

Extension

How would a rehab plan for a warm-water fishery such as the one found in Flaming Gorge Reservoir differ from a rehab plan for Colorado River cutthroat trout? Use the web and other references to identify their similarities and differences.

Rehab *EcoVenture*

As you use each tool, record its cost. Record the number of fish observed at each sampling site for each year. Calculate a total for each year. *To get accurate counts, place the shocking tool hoop on the sampling point.*

Table 1. Shocking Results

	A	**B**	**C**	**D**	**E**	**F**	**BASELINE TOTAL**
BASELINE							

Table 1 a. Plant willows

SAMPLING SPOT	**A**	**B**	**C**	**D**	**E**	**F**	**YEARLY TOTAL**
Year 1							
Year 2							
Year 3							
Year 4							

1. What was the cost for planting willows? $_____

2. How efficient was planting willows to provide shade and reduce stream bank erosion? (Hint: Divide the cost of planting willows by the number of fish counted in year 4 total. Round off to the nearest whole number)
$_____ per fish

3. What are some additional reasons planting willows is a good rehab strategy?

_____

_____

_____

Table 1 b. Silt dike

SAMPLING SPOT	A	B	C	D	E	F	YEARLY TOTAL
Year 1							
Year 2							
Year 3							
Year 4							

4. What was the cost for installing the silt dike? $_____

5. How efficient was the silt dike in reducing stream bank erosion? $_____ per fish

6. What are some additional reasons for installing a silt dike? _____

_____

_____

_____

Table 1 c. Grade control structures

SAMPLING SPOT	A	B	C	D	E	F	YEARLY TOTAL
Year 1							
Year 2							
Year 3							
Year 4							

7. What was the cost to install grade control structures? $_____

8. How efficient was installing grade control structures? $_____ per fish

9. What are some additional reasons for installing grade control structures?

_____

_____

_____

Table 1 d. Soil netting

SAMPLING SPOT	A	B	C	D	E	F	YEARLY TOTAL
Year 1							
Year 2							
Year 3							
Year 4							

10. What was the cost to install soil netting? $_____

11. How efficient was installing soil netting to reduce stream bank erosion? $_____per fish

12. What are some additional reasons to install soil netting? _____

_____

_____

_____

Table 1 e. Remove cattle

SAMPLING SPOT	A	B	C	D	E	F	YEARLY TOTAL
Year 1							
Year 2							
Year 3							
Year 4							

13. What was the cost of removing cattle? $_____

14. How efficient was removing the cattle to reduce stream bank erosion and water pollution? $_____/ fish

15. What are some additional reasons to remove cattle after a wildland fire? _____

_____

_____

16. What combination of tools do you think will be most efficient? Write your hypothesis and reasons why these techniques were chosen here.

_____

_____

_____

To install more than one Rehab tool, click on your choice of tools. You can click on one, two or more.

17. Based on the results from your simulation, was your hypothesis correct? Write your conclusion based on the simulation. _____

_____

_____

After you have completed all the parts of Table 1 (a. through e.), answer the following questions about rehab strategies after a wildland fire.

18. Explain why installing grade control structures might not be the best strategy for rehabbing Currant Creek.

_____

_____

_____

19. What single rehab Tool was the most effective in restoring the population density of Colorado River Cutthroat Trout?

_____

_____

_____

20. What Tool was the least effective?

_____

_____

_____

21. Rank the Tools in terms of efficiency as measured by the costs per fish. If you had limited funds, what Tool or combination of Tools would you recommend be used to rehab this area?

_____

_____

_____

Flames EcoVenture

Introduction

In this ***EcoVenture*** you will practice managing wildland fires. You will be responding to varying environments with differing fuel types and fuel moistures. Fires may burn with low or high fire behavior conditions. There may be changing wind direction or speed.

Why It's Important

Fire management involves many decisions that must be made quickly and based on a good fire management plan. You need to consider human risks and safety, the ecological impact of wildland fire, the weather conditions, type of fuel, fire behavior, costs, and the available fire suppression resources. You may manage and monitor rather than suppress a fire due to the location of the fire and the hazards in the area. The costs of suppressing the fire compared to letting it burn naturally are another major consideration. The best decision may be to let it burn. In this ***EcoVenture***, you will practice making important fire management decisions.

Ready? Begin

The ***Flames EcoVenture*** is a real challenge. This simulation is based upon the one used by the National Interagency Fire Center (NIFC) to train firefighters. Stick with the activities and apply what you have learned earlier. Complete the Simple level first, and when you have mastered that one, continue on to the Intermediate and Advanced levels.

Click on the link for any of the Intro Activities. Familiarize yourself with the environment by clicking the **Show Ecosystems** button. Start the simulated wildland fire by clicking the **Play** Button at the top left of the Flames screen. You can pause the simulation by using the **Pause** button. Use the Play button to resume. Clicking the **Stop** button will reset the simulation back to the beginning. As the simulation progresses, you will see windows showing the time, total elapsed time, wind speed (km/h) and direction, total hectares burned, number of buildings lost, and the total cost of the fire (both in hectares lost and the cost of using the equipment and personnel).

There are six **Tools** represented by icons, available to help you manage the fire. These Tools include a **bulldozer**, a **tanker plane**, a **helicopter** with a water drop bucket, a 20-person **hotshot crew**, a **water tanker truck** and a **backfire** tool.

To select a tool, click on the icon to activate it. Try the hotshot crew tool. Draw out a path for the hotshots to construct a hand line (fire break) by clicking down a set of successive points on the aerial map near the fire. Once you have a path drawn out, click on the **Deploy** button and the crew will build a hand line following that path you have made. Clicking the **Cancel** button will cancel the hand line and allow you to redraw the path (or select another tool). If a crew becomes threatened by the fire while building a hand line, simply click the icon and click the

Cancel button to evacuate the crew. Be careful, if fire overruns a crew, that crew is permanently disabled and unavailable for the rest of the simulation. All of the ground-based equipment work like the hot-shots crew.

The **tanker plane** works a little differently. It must land, reload, and fly back to the area between slurry drops, so it may not be immediately available. If you click on the tanker plane and it is not available, you will get an indicator letting you know what time it will be available. To draw the path after selecting the air tanker, click one point on the map—this will be the **beginning point** of the slurry drop. Clicking a second point will choose the **direction** that the tanker will lay down slurry from the beginning point. The tanker can only drop a limited amount of slurry, so the distance from the beginning to end point is fixed. After your line is drawn, click **Deploy** to drop the slurry. Aircraft are normally used to attack the head of the fire. You may also use aircraft to knock the fire down near the resources being used to build a fire line. Clicking **Cancel** will let you start over if you want to place the slurry drop in a different area.

The **helicopter** must also reload (usually by dropping its bucket into a nearby water reservoir) between drops, so it will also be unavailable for a short time between drops. To pick the drop point after selecting the helicopter, click on a single point on the map. A small dot will appear indicating the area that will be covered by the water drop. Click **Deploy** to commit to the water drop point selected. Helicopters can also be used to attack the head of the fire or to provide protection for resources under immediate threat from a fire. Clicking **Cancel** lets you start over.

By selecting the **backfire** tool, you can start backfires to burn out the fuel in front of an advancing fire. Simply click on the map to start a backfire. The burn out should generally burn from the fire line toward the main fire. Be careful with wind direction, as a backfire could accidentally overwhelm a crew in the process of building a fire line. Backfires can be used to burn out an area where the fire is already contained. Be careful not to start new wildfires because the backfire tool will start a fire wherever you click.

When the fire is out, the incident commander will indicate that all fires are contained and the simulation will stop. To reset the simulation, click the **Play** button again.

Now you are on your own. Choose another lesson and use your resources wisely. Consider the costs and hazards involved. Do you need to limit the use of heavy equipment to keep resource damage and costs down? Can you let the fire play a natural role and simply monitor it? Will you need to aggressively suppress a fire in challenging conditions?

Record your decisions and other data from the simulation in Table1.

Table 1. Fire Management Log

Team Members _____ _____

_____ _____ _____

Flames level _____

Objective: Manage _____ Suppress _____

Elapsed time needed to manage the fire	**Hectares burned**	**Cost in dollars**	**Wind speed**	**Wind direction**	**Environment**	**Tools used**	**Buildings lost**
Less than 1 hour							
1 hour							
2 hours							
3 hours							
4 hours							

From the data in Table 1, construct graphs to compare the costs, hectares burned and the elapsed time for several ***Flames*** lessons.

1. Write a paragraph describing the firefighting resources used and why they were called up for each fire. What wildland fire strategy did your team use; management for the natural benefits or aggressive suppression of the fire? Support your decision to let it burn or to suppress it. Did you have injuries? How did they occur?

_____

_____

_____

2. Compare and contrast the costs and benefits of each resource.

_____

_____

_____

_____

_____

_____

3. In a ***Flames*** lesson of your choice, rank your choice of resources according to the fastest suppression time and lowest cost.

_____

4. Describe a general plan to manage a wildland if your budget was limited. What equipment and human resources would you use? How would you measure success?

_____

_____

_____

5. Your team is in charge of a "challenging" wildland fire. Use the ***Flames*** simulation to identify the firefighting resources you can use to suppress this fire in 24 hours (or less). Justify your choices. Were you able to provide for the safety of your people?

_____

_____

_____