43. *Post-fire Survival of Bosque Trees*

Description: Students interpret real data from the Rio Grande bosque to determine the effects of fire on the growth and survival of different tree species.

Objective: Students will learn techniques to interpret data and will understand how different plant species are affected by fire (in other words, fire's positive and negative effects on ecosystems).

Materials: pencil, graph paper, markers or colored pencils, ruler, newspaper articles about bosque fires

Background: Many plant species occur in ecosystems adapted to fire, and these plants have a variety of adaptations to survive fires. Some trees have thick bark to protect living tissues inside, or may lack low branches to prevent fire from climbing into the canopy. Many herbaceous plants survive by producing seeds that are able to withstand the heat of fire, or may only sprout after a fire has passed over. Other plants can sprout from underground roots or from charred stumps that remain in the wake of a fire.

It is likely that fire was not an important part of the bosque ecosystem prior to the arrival of humans. Lightning strikes in adjacent uplands started fires that may have burned into the bosque, but these probably remained ground fires that swept quickly through grasses and forbs and did not greatly affect cottonwoods. In contrast, flooding and herbivory (eating by animals such as beavers) were more important in this ecosystem, and riparian plants are likely adapted to re-sprout after these disturbances, rather than after fire per se. The ability of cottonwoods and other native riparian shrubs and trees to sprout from trunks or roots after being knocked over

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Grades: 6–9

Time: one or two class periods

Subjects: math, biology, ecology

Terms: *fire intensity, fire severity, leaf litter, mortality, regeneration*

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in a flood or being chewed by a beaver, however, does allow them to re-sprout after fires as well. Many of the exotic species now present in the bosque are also able to sprout after fires.

The mortality (death) of trees after a fire in the bosque depends on the severity of the fire. *Fire severity* is a measure of the degree to which a fire alters a given site and is used to estimate the *intensity* of the fire (intensity itself must be measured directly during the fire, based on heat production). Fire severity can be determined after a fire based on characteristics such as the extent of burn (char) on a tree or the amount of leaf litter remaining on the ground after the fire. A light-severity fire may damage trees, but they usually survive, while more severe fires will kill more trees. Often the above-ground portion of the plant dies (it may remain standing, fall over or even be completely consumed by the fire) but the plant is able to sprout from the base of the trunk or from underground roots. Typically sprouting occurs after light- to moderate-severity fires, while high-severity fires cause complete mortality. If post-fire conditions are right—enough moisture and not being eaten by browsing animals—the newly sprouted trees may survive after a light- to moderate-severity fire.

With the increasing impact of fire in the bosque, biologists have been studying the effects of fire on the survival of riparian plants. Here we will use data collected in the field to monitor the survival of cottonwood, saltcedar and Russian olive after two different fires in Albuquerque.

References: Ellis, Lisa M. 2001. Short-term response of woody plants to fire in a Rio Grande riparian forest, Central New Mexico. Biological Conservation 97: 159-70

Stuever, Mary C. 1997. Fire Induced Mortality of Rio Grande Cottonwood. Master's thesis, University of New Mexico.

Procedure:
1. Access prior knowledge: Discuss the effects of fire on life in the bosque. Review definition of fire severity. Show "Before and After a Bosque Fire" photos included in this activity.

2. Divide into cooperative learning groups of two or three. Give each group a set of the student copy pages along with markers, graph paper and pencils. Follow directions on worksheets.

3. Once students have filled out their sheets, compare the results with the entire class.

Discussion Questions:

Teacher Key Part 1

1. *Bar graph*

2. What are some initial conclusions you can draw from these results?
   Cottonwood mortality is high, even in a light fire; mortality increases with fire severity.

3. What factors would cause a high-severity fire?
   Dry conditions; high winds; lots of dead and down wood/branches; deep, dry leaf litter.

4. Do you have any ideas as to why the rate of cottonwood mortality increased with the severity of the fire?
   Hotter fires burn more and kill more; if fire burned through the living tissue of the tree under the bark; fire burned living tissue on all sides of the trunk; tree lost too many of its leaves and small branches.

5. How might land managers (e.g. New Mexico State Forestry Division) use this information?
   Managers should reduce fuel build-up within the bosque, and fire fighters should work at keeping fire out of cottonwood areas.

Teacher Key Part 2

1. Calculate the percentage of trees with sprouts for each tree species.
   Saltcedar   89.6 percent
   Cottonwood   81.1 percent
   Russian olive   99.2 percent

2. Which type of tree had the highest percentage of regeneration (sprouts)?
   Russian olive

3. Which type of tree had the lowest percentage of regeneration (sprouts)?
   Cottonwood

4. Create a graphic representation of this data.
   Answers will vary—bar graphs or pie charts will work.

5. Did native or exotic plants have higher survivorship?
   Exotic

6. What conclusions can you draw from this data?
   Even if the upper tree dies in a fire, some trees will sprout from their roots. Exotics are sprouting more than native plants.

Extensions: Look on the Internet for articles about bosque fires. What can you tell about the severity of fires described in news stories?

This U.S. Army Corps of Engineers web site has information about fires and restoration in the Rio Grande bosque: www.bosquerevive.com

Go on a field trip to a recent burn site and look at fire severity. Here are some things to look for:
- amount of leaf litter burned
- char on root collar (tree base)—Black all around? Burned through bark into wood? Are roots burned as well? Draw a circle to represent the tree base in cross-section and mark the portion that is scorched.
- trunk—highest scorch, highest scorch all around, if burned through bark into wood.
- crown—green today? Any visible scorching?
- number of trees sprouting from roots or trunk when above-ground portion is dead.
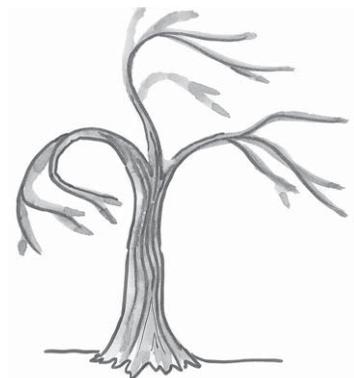
Post-fire Survival of Bosque Trees

Part 1

Fire severity is a measure of the degree to which a fire alters a given site. Fire severity can be determined after a fire based on characteristics such as the extent of burn (char) on a tree or the amount of leaf litter remaining on the ground, and is used to estimate the effects of fire intensity.

• Light-severity fires had leaf litter that was burned in patches but not entirely consumed.

• Moderate-severity fires had most of the leaf litter consumed, although some patches of unburned material remained.

• High-severity areas had no remaining forest floor litter; these areas were often characterized by patches of white ash against black soil.

Here are data describing mortality after three types of fires in the Albuquerque area.

Fire Severity			
	Light	Medium	High
Cottonwood Mortality	60%	75%	100%

1. Make a bar graph of these results on a separate page.

2. What are some initial conclusions you can draw from these results?

3. What factors would cause a high-severity fire?

4. Do you have any ideas as to why the rate of cottonwood mortality increased with the severity of the fire?

5. How might land managers (e.g., New Mexico State Forestry Division) use this information?

Post-fire Survival of Bosque Trees

Part 2

The following data describe the survival of three different species of trees: native cottonwoods and exotic saltcedar and Russian olive. The above-ground portions of these trees were killed by the fire. These data show which trees sprouted from the roots within 90 days after the fire. Kim Lester and her Bosque School students collected these data following the Montaño Fire of June, 2003, on the west side of the Rio Grande.

| Species	Total Trees	Trees w/ Sprouts	% w/ sprouts
Saltcedar	222	199	
Cottonwood	154	125	
Russian olive	250	248	

1. Calculate the percentage of trees with sprouts for each tree species.

2. Which type of tree had the highest percentage of regeneration (sprouts)?

3. Which type of tree had the lowest percentage of regeneration (sprouts)?

4. Create a graphic representation of this data.

5. Did native or exotic plants have higher survivorship?

6. What conclusions can you draw from this data?

Before and After a Bosque Fire
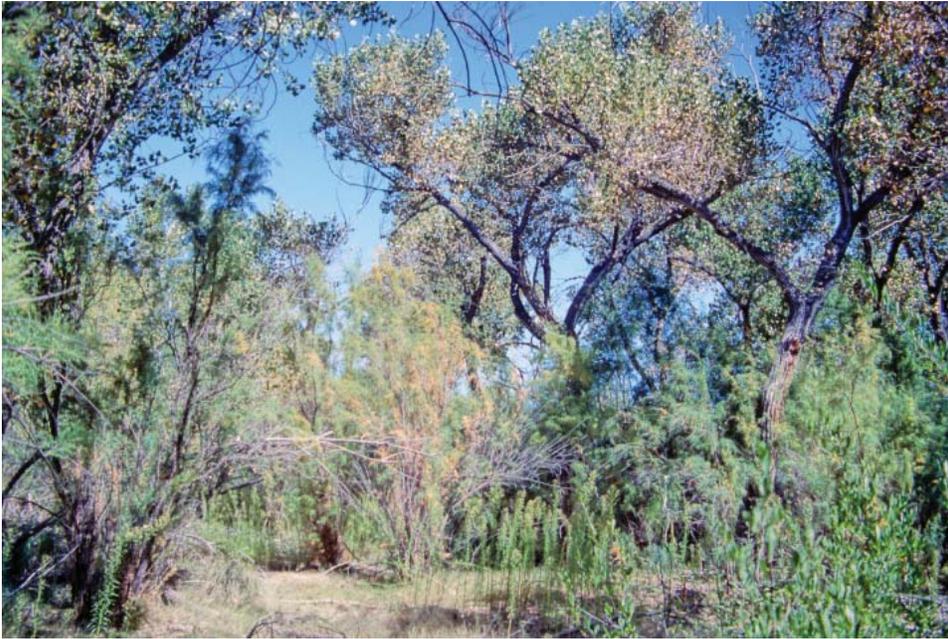
The Bosque del Apache National Wildlife Refuge near Socorro, NM, was lush and green in September 1992.

The same spot was photographed on June 20, 1996, shortly after the San Pedro fire.

Although above-ground tissues of cottonwoods were completely killed, tree roots were already sprouting on August 16, less than two months after the 1996 fire.

Growth was abundant on August 23, 1998, two years after the fire. Photos by Lisa Ellis.