



13.

Changing River

The Base Activity for the Rio Grande Model

Description: In a directed class activity, students build a model of a section of the Rio Grande Valley as it was before major human intervention, and then manipulate it to demonstrate today's river. In working with today's river, the students contrast the differences between managing the river for only human benefits and managing the river with broader objectives including ecosystem health and human needs.

Objective: To understand:

- the differences and similarities of the way the river was (Rio Bravo);
- the way the river has been significantly altered by humans in the last century (Rio Manso); and
- the way the river can be managed to support a healthy ecosystem (Rio Nuevo).

13. Changing River



Grades: This model can be used with all ages, from kindergarten through adult, with discussion geared to the appropriate level. The discussion in this write-up is geared for Grades 3–8.

Time: Initial material preparation: about 30 minutes. Activity: a minimum of one hour to assemble the river, learn where the components are placed, and summarize how the river changes. This activity can be paired with others ("Who Lives Where," "Who Grows Where," "Cottonwood Creation," etc.) and can take many class periods.

Subjects: science, social studies

Terms: bosque, riparian, riverine, acequia, levee, meander, oxbow, seedling, sapling, sand bar, snag



Materials:

For assembly:

scissors to cut the pieces

envelopes or plastic sandwich bags to hold the pieces and information cards

1. copy of information cards in this activity or kit materials from workshop
2. five copies of model components in the kit
3. Your class can then make the following:

Before alteration pieces (Rio Bravo):

- 100 cottonwood seedlings
- 20 cottonwood saplings
- 10 mature cottonwood trees
- 100 cattails
- 5 sand bars
- 1 grassy meadow
- 7 riparian native shrubs
- 15 upland shrubs

After alteration (Rio Manso):

- 20 houses or other buildings
- 30 riparian or exotic trees
- 10 snags (still-standing trees killed by fire or disease)
- 2 (or more) irrigation ditches or drains (below)
- 2 levees
- 10 agricultural fields
- 1 large dam
- 3 small diversion dams
- 10 additional mature cottonwood trees
- 5 additional upland shrubs
- 4 burned snags

Restoration pieces (Rio Nuevo):

- 6 monitoring plots

Have students cut out the pieces. Place all of one kind into an envelope or sandwich bag and include the information card for that feature. Keep the Rio Bravo, Rio Manso, and Rio Nuevo pieces separate.





Additional model components (by color and/or instruction):

4. one tan, white, or brown blanket, sheet, or large cloth at least 6 to 8 feet (2 to 2.4 meters) long for the Rio Grande Valley
5. strips of blue fabric about 6 to 12 inches (15 to 30 cm) wide for the river. Length should be about three times the length of the valley (blanket, etc., above). You can make long cuts lengthwise in the fabric for braids and meanders. Small separate pieces can be used to construct oxbows or ponds.
6. two brown ribbons or thin fabric strips for levees, 8 feet (2.4 meters) long each
7. blue ribbons for ditches or drains, two 8-foot (2.4-meter) ones and other shorter lengths to reach to fields from the river (The activity "Working Water" requires additional sizes and colors of ribbons for ditches, drains, etc.)
8. Complete kits for this activity may be borrowed from the locations listed on the card in the front pocket of this binder.



evening primrose

(Note: Flower and cottonwood photographs in this unit are from New Mexico Museum of Natural History collections. Others are from the New Mexico State Parks Archive.)



This human-made pond at Mesilla Valley Bosque State Park resembles those created by Rio Bravo as part of the mosaic of habitats on a sinuous, changing river.



Native species like Goodding's willow were typical of the Rio Bravo.



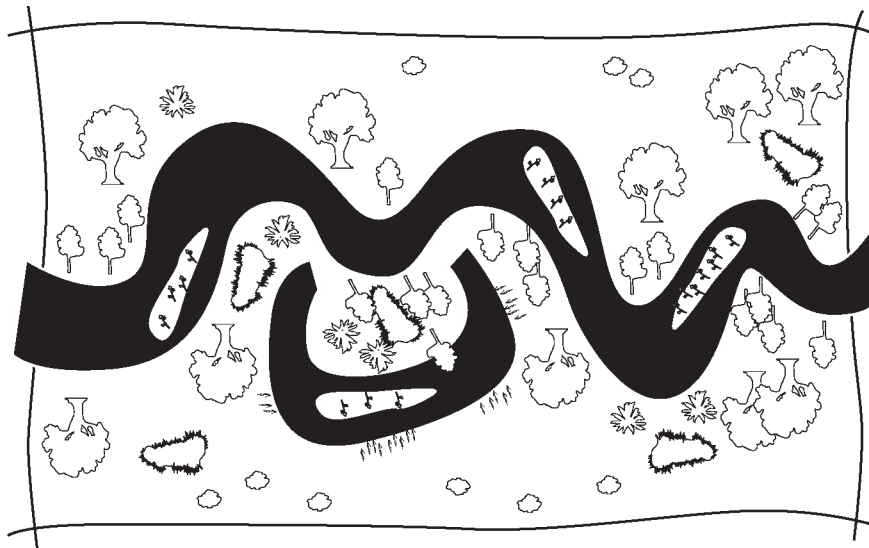


Background: This activity builds a model of a section of the Rio Grande Valley. Models are tools that help us understand complex systems by simplifying their components. We use models to help demonstrate ideas that are not as easy to grasp when working with a real ecosystem.

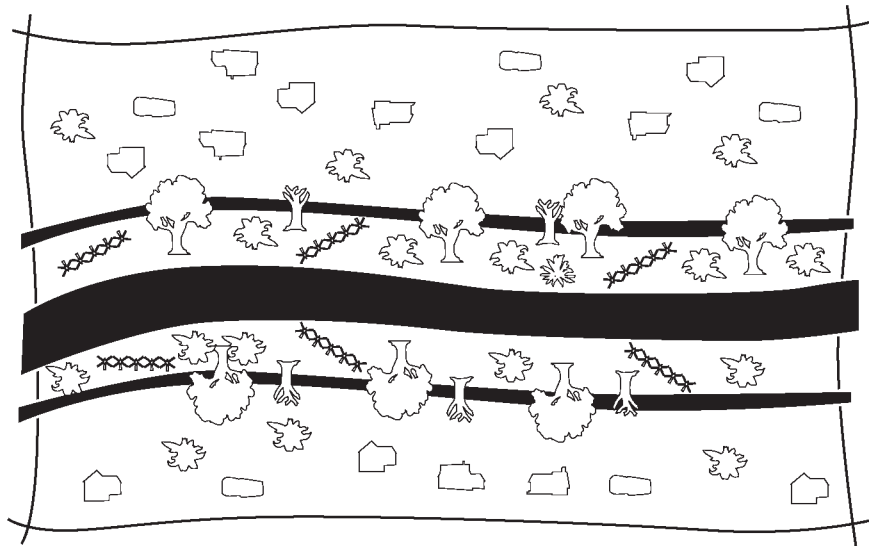
One way to understand the relationship of the bosque to the Rio Grande is to think about the Rio Grande as “different rivers” depending on time. Long ago, the Rio Grande functioned much differently than it does today. Although people have used the river’s water for irrigation for probably thousands of years, they did not start harnessing the river water behind large dams or changing the river’s natural hydrological functions until this past century. In the model we call this old river Rio Bravo, which is the historic name for the Rio Grande meaning wild, brave—an untamed river.

In contrast, we call the river that has been highly altered by humans Rio Manso. Manso is a Spanish word that means tamed, such as a horse that has been broken to riding. For many years, changes were made to the river system with the top priority being how the river was serving the human society. Little attention was given to the ecosystem and the other animals and plants that depended on this important riparian corridor.

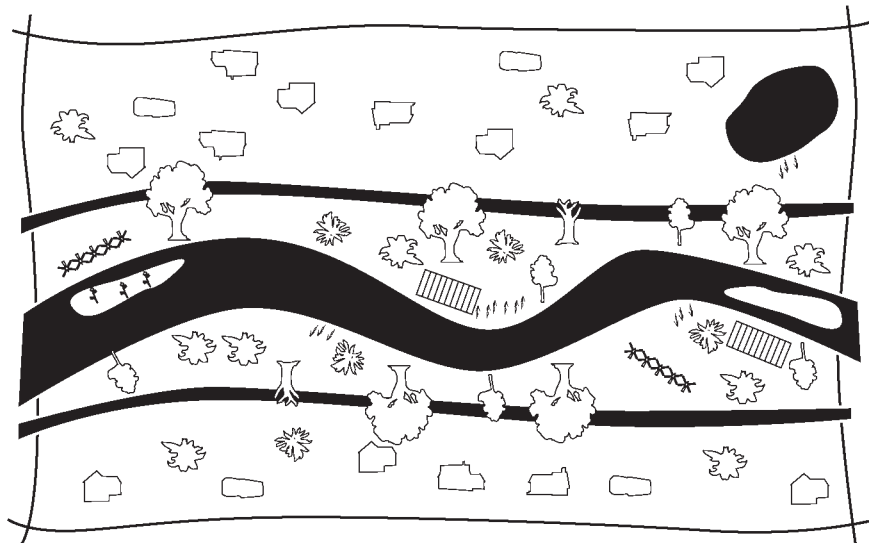
In 1993, an important document, the Middle Rio Grande Ecosystem: Bosque Biological Management Plan, brought a focus on the problems of prioritizing river management for human needs only. Many projects before the plan attempted to address biological issues on a small scale, and since its publication river managers have been more active in managing the river for both human needs and ecosystem health. In our model exercises, we call this third river Rio Nuevo—a new river that meets human constraints but provides a healthy ecosystem with as many of the Rio Bravo features as can be allowed. This river will always be evolving. In actuality, there will always be places along the river that are more like Rio Manso and other places that are more like Rio Nuevo. When students ask what river we have today, we can tell them we have both, depending on what features the river and bosque have where we are looking.



Rio Bravo



Rio Manso



Rio Nuevo





Procedure:

Introduction to “Changing River” Model

Use the following to get your students started.

Vocabulary and Discussion Questions for Introducing Rio Bravo

riparian: (Latin root means “at a river”) relating to or living or located on the bank of a natural fresh watercourse such as a river, stream or pond

oxbow: U-shaped river channel that has been cut off from the main flow of a river causing a pond or lake to form

meander or bend in the river: the way a river bends or curves

braid in the river: the manner in which a river splits into several channels forming islands between the waterways

seedling: a young plant grown from a seed. Often refers to a tree that has germinated or sprouted, but has not reached sapling size; (“baby trees”)

sapling: a young tree, generally taller than 4.5 feet (1.5 meters) and less than 4 inches (10 centimeters) in diameter (“teenage trees”)

bosque: Spanish word for “woods”; in the Southwest it is used to describe the forest of trees along a river

(See Terms for other words to introduce to your students.)

What is in a bosque? Water, trees, animals, bugs, soil . . .

What animals have you seen in the bosque?

What is the main native tree in the Rio Grande bosque?
Cottonwood.

How does the bosque differ from the higher area surrounding the bosque? Are the same plants in the bosque and in the higher areas surrounding the bosque? (Keep in mind that cities will water yards and parks in the upland areas, but in natural areas there are very different plants and animals.)

What makes the bosque different? The water! (get your students to think through this, it is a very important concept.) The water table is near the surface and plants can reach down to get water.

Cottonwood trees are very important to the bosque. Can anyone tell me how they reproduce? What type of seeds do they have? The seeds are attached to fluffy cotton and they are carried by the wind up and down the river. They need special conditions in order to sprout: wet soil, an open area with lots of sunlight, and the roots must be wet as they grow—during the summer the ground water drops, and if the roots of the sprouted seeds don’t stay wet the seedlings will die.



oxbow



meander



braid

Section A: Rio Bravo



Setting Up the Rio Bravo Model

1. Initiate the activity by explaining to students that they will be building a model of the river and the bosque.
2. Lay out the basin (blanket, sheet or other material) with raised edges along the two longest (opposite) sides. Since you want the students walking on the model without shoes, you might suggest they place their shoes under the edges to create the raised edges (valley); lunch boxes or books work, too. Students may raise all four sides of the basin at first. This is an excellent opportunity to discuss closed basins and explain that long ago, before the Rio Grande was a river, it was a series of lakes in closed basins. Then adjust the model so the two shortest sides are not upraised to emphasize that it is a valley, with the river coming in one end and out the other end.
3. Have students place the river down the center of the basin. Explain that since they are laying out Rio Bravo, the river should have:
 - large meanders or turns
 - oxbows—old abandoned channels separate from the river that are marsh areas (use small pieces of cloth)
 - braids—loop the fabric or make slits in the river material to represent the braided river
4. Hand out only the Rio Bravo (pre-alteration) envelopes to the students. Teams can be given the larger number of items.
5. Ask students to read the card in the envelope and figure out where in the basin their pieces should be placed, and then place them. Pay close attention to the limitations for each of the items in the bags.
6. Go around the class with each student/group discussing why their item was placed where it was.
7. Explain that this is what the river was like before humans made changes to the river.





Rio Bravo Discussion Questions (after model has been laid out by students).
Have the students describe the landscape they have created.

- The end result is a “mosaic” of mini habitats. A grove of old cottonwood trees here, a group of teenage trees (saplings) there, and baby trees (seedlings) in another spot. There was not a continuous forest of large cottonwoods along the river, but a patchwork of different-aged stands of trees. Each year the river might change course, taking out plants that had been there, but providing new open areas for seeds to get established.

- What role does spring runoff play in the ecosystem?

Every three to five years the river would flood over its banks due to high runoff from snow in the mountains. During overbank flooding in spring, river water saturates the branches and leaves that have fallen on the ground in the bosque. This wet debris decomposes more quickly than dry leaves and sticks. Microscopic organisms such as bacteria and fungi feed on the downed material. The dead material is broken down into nutrients used by other plants. This is called nutrient cycling.

At this point, you may want to proceed on to Section B, Transitioning to Rio Manso, or you may want to do the first parts of “Cottonwood Creation,” “Who Lives Where?,” “Who Grows Where?” and/or “Bosque Chaos.”



cottonwood tetones



Section B: Transitioning to Rio Manso

Pass out the components for Rio Manso (the changed, tamed or altered river).

Following the time line below, have students restructure the river adding the new components and taking away older components as indicated by the timeline events. Check the final image of the model against the list of changes in “Discussion Questions After Rio Manso.”

Directions: Going from Rio Bravo to Rio Manso: Timeline for the Lower Rio Grande and Mesilla Valley, New Mexico

Here is a time line for making the transition from Rio Bravo to Rio Manso. Items with ✓ give instructions for making changes to the model.

2,000 years before present: The Mesilla Valley’s earliest inhabitants, the late Desert Archaic (are-KAY-ick) people left evidence of erect structures and agriculture.

200 A.D.: Early Puebloan peoples known as the Jornada Mogollon (horn-ah-da mog-oi-YOWN) began to gather in villages and larger, scattered settlements and engaged in trade to acquire materials from far away. Dryland corn farming started in conjunction with the traditional hunting and gathering survival strategy.

✓ add one small agricultural field

1100 A.D.: Jornada Mogollon farmers began living in in pithouses and adobe pueblos along the Lower Rio Grande. Some settlements housed several hundred people.

✓ add one pueblo-style house

1275–1300: A major drought struck the Southwest and many areas without permanent water were abandoned. Because of its reliable water, the Rio Grande became a focus for settlement. The people grew corn, beans, squash and melons.

✓ add another pueblo-type house

✓ place a few agricultural fields

1400: Athapaskan-speaking ancestors of today’s modern Apache peoples entered the Lower Rio Grande area. The river became the traditional boundary between Mescalero and Chiricahua Apache bands.





1598: Juan de Oñate set out from Mexico with his caravan of 400 people, 80 wagons and 7,000 head of livestock to colonize New Mexico. He forged a permanent supply route, called El Camino Real de Tierra Adentro (el cam-EE-no re-AL de tee-AIR-ah ah-DENT-row), connecting Mexico with soon-to-be-built Spanish missions.

1600: Spanish settlers constructed the first acequias (ah-SAY-kee-ahs) (canals or ditches) near present-day Las Cruces, Santa Fe and Española, New Mexico.

- ✓ put an acequia from the river to a field

1839: The Village of Doña Ana was founded through a grant from the Mexican authorities to Jose Maria Costales and 110 people. Hispanic settlers began farming in this area.

- ✓ add four more houses along the river

1844: Large floods occurred, dramatically changing the course of the Rio Grande, which began to flow on the east side of the valley, east of where Mesilla is today. At this time the channel was surveyed as a boundary of the Doña Ana Bend Colony Grant.

- ✓ river is “east” of houses

1848: The Treaty of Guadalupe Hidalgo ending the United States–Mexico War ceded most of New Mexico to the United States. The treaty protected the property rights of Mexican citizens in ceded territories, including acequias. Las Cruces was founded this same year.

- ✓ add three more houses
- ✓ place the longest irrigation ditches on each side of the river on the model
- ✓ add more agricultural fields

1850: Sixty Hispanic families in Las Cruces, not wanting to become United States citizens, moved across the Rio Grande and built a village atop a hill or “mesita” which eventually becomes Mesilla.

- ✓ add two houses for second village to the “west”

1853: The Gadsden Purchase established the current boundary between the United States and Mexico. The village of Mesilla was back in the United States.

1862–1865: The Rio Grande channel shifted to its present location along the west side of the valley—west of the village of Mesilla.

- ✓ move river to the “west” of both villages



1893: Rio Grande Dam and Irrigation Company filed to construct a dam at Elephant Butte.

1902: The Reclamation Act was passed into federal law and the U.S government entered the business of constructing large-scale water projects.

1907: Construction of Leasburg Diversion Dam was completed.

- ✓ place small dam on the river
- ✓ connect irrigation ditch between dam and fields

1916: Construction of Elephant Butte Dam was completed and the lake began to form. Construction of the Mesilla Diversion Dam was completed.

- ✓ place large dam on the up-river end of the river model
- ✓ remove 90 cottonwood seedlings (leaving 10), since lack of flooding means reduced natural regeneration; leave remaining seedlings on sandbars and immediately adjacent to river
- ✓ place small dam on the river
- ✓ connect irrigation ditch between dam and fields

1922: Reclamation Service agreed to deliver 66,650 acre feet (82,211,564 m³) of water to the El Paso Water Improvement District from Elephant Butte.

1930s: Saltcedar spread through the valley.

- ✓ add exotic riparian trees

1938: The Rio Grande Compact among Colorado, Texas and New Mexico apportioned Rio Grande water between them and reaffirmed the 1906 treaty with Mexico, ensuring 60,000 acre-feet (74,008,900 cubic meters) of water per year to Mexico. In addition, construction of Caballo Lake Dam (cab-EYE-yo) was completed.

- ✓ place small dam on the river
- ✓ connect irrigation ditch between dam and fields

1938-1943: Under the Rio Grande Canalization Project, 106 river miles (170 km) from Percha Dam to American Dam in El Paso were straightened, confined to a single channel and lined with levees to protect towns from flooding. The project facilitated delivery of water to Mexico under the 1906 treaty. Small dams were built on side-streams to reduce sediment flowing into the valley. To keep vegetation from blocking water flow during flooding, regular mowing of the floodplain began. Routine dredging kept a uniform channel depth for efficient delivery of water.





- ✓ place levees along each side of the river on the model. You should straighten and narrow the river as you do this.
- ✓ leave a total of four mature cottonwoods below any of the dams; remove others
- ✓ remove all remaining vegetation, except grass, from between the levees
- ✓ remove sandbars from the river
- ✓ add three houses
- ✓ move five upland shrubs into the riparian area, because the water table is dropping and the bosque is losing its hydrological connection with the river, allowing plants tolerant to drier conditions to become established

1955: An estimated 86,153 acres were under irrigated cultivation, nearly the maximum number allowed under the Rio Grande Compact. Crops included chile, pecans, cotton and alfalfa, among others. The population of Doña Ana County was nearly 60,000.

- ✓ add the rest of the agricultural fields
- ✓ replace two mature cottonwoods with snags due to drop in water table

1985: Several seasons of heavy run-off filled Elephant Butte and Caballo reservoirs to capacity.

2000: A marsh/pond was built in the area of the future Mesilla Valley State Park. Cottonwood poles were planted.

- ✓ replace five cattails
- ✓ replace four native riparian shrubs
- ✓ place five cottonwood saplings

2006: The population of Doña Ana County was 194,000. Population projections exceeded 220,000 by 2010, spreading into desert and land that was once used for farming.

- ✓ add remaining houses
- ✓ remove two or three agricultural fields

2008: Mesilla Valley Bosque State Park opens, preserving three miles (4.8 km) of Rio Grande floodplain on the west side of the river.

At this point, you may want to proceed to Section C, Transitioning to Rio Nuevo, or you may want to continue Rio Manso-related activities: "Cottonwood Creation," "Who Lives Where?," "Who Grows Where?," Working Water and "Bosque Chaos."



Discussion Questions After Rio Manso

What will happen to the cottonwood trees eventually if there are not enough new seedlings to take their place?

They may die out and be replaced by non-native trees that do not rely on spring flooding for regeneration.

Do you think the same animals can live in both river systems?

No, because the habitat is different. Some animals may not find their habitat in the new system.

What kinds of habitat were available in Rio Bravo that is not as available in Rio Manso?

Wetlands, marshes, recently abandoned river channel

What are the differences between Rio Bravo and Rio Manso?

Students should have made the following changes to the model:

- A great reduction in the number of cattails, since slow or standing water is harder to find (occasionally found near the sides of sand bars)
- A relatively straight river. Curves are there, but no large meanders, oxbows, etc. Sand bars are still present, but braiding is greatly reduced.
- A narrower river channel
- Levees on each side of the river channel (there should be only a few inches between each levee and the river bank)
- Irrigation ditches from the dam provide water to the valley
- The majority of the mature cottonwood trees are between the river bank and the levees. Some large trees can still be found elsewhere in the valley.
- A decrease in the number of cottonwood seedlings and saplings. Seedlings can be on sand bars, but are frequently washed out, so rarely reach sapling size.
- A reduction in native shrubs, and an increase in exotic shrubs, found primarily in the strip of land between the river and the levees
- There should be a dam across the upper edge of the valley from upland to upland.

Can Rio Manso become like Rio Bravo again?

Probably not. It would increase the risk of flooding. It would be difficult to eradicate the introduced plants. Many native species are now extinct and can never come back.

Do you think anything can be done to make Rio Manso more like Rio Bravo?

Probably. Let students brainstorm.





Section C: Transitioning to Rio Nuevo

Discussion and Procedure: Transitioning to Rio Nuevo

Let's look at ways to make Rio Manso more like Rio Bravo.

Today's land managers know more about the effect of the major projects installed along the Rio Grande in the 20th century. They are now taking measures to ensure a variety of habitats that will provide appropriate places for the natural biodiversity of the valley and improve the situation for some endangered and threatened species.

Divide students into nine teams and pass out a "Rio Nuevo Habitat Restoration Project" card to each team. Have students read the information on their cards and follow the instructions to make changes on the model. (An alternative way to manage this activity is to have the class work as a group on each project. This works particularly well with small class sizes.)

Have each team tell the class what their project was and what changes they made on the model. Explain that we call this new river **Rio Nuevo**.

Share the story of an actual restoration project, "Bulldozers in the Bosque" (page 86), to discuss a real-world project, the Albuquerque Overbank Project, and its effects.

Ask the students if they see the potential for other projects that will help to restore the river. Encourage them to come up with original ideas and make the changes on the model.

Ask the students to explain the differences between Rio Nuevo and Rio Manso:

- more opportunity for the next generation of cottonwood trees
- more natural river features, such as meanders, oxbows, braids
- fewer exotic species

...the list will vary

Today's river has elements of both river concepts we used in our model. Ask the students to give examples of how the Rio Grande today is like Rio Manso and Rio Nuevo.

Rio Manso

Levees, saltcedar stands, irrigation canals, farm field, etc.

Rio Nuevo

Pole plantings, fewer exotic species, new marshes built, etc.



At this point you may want to continue with model activities “Cottonwood Creation,” “Who Lives Where?,” “Who Grows Where?” or “Bosque Chaos” that have Rio Nuevo sections.

Assessment: To celebrate finishing the River of Change unit have students decorate three cakes for the three different river models they studied.

Materials: three sheet cakes with plain icing; squeeze icing in different colors, knife, plates, napkins and forks. Divide class into three teams, assign each team either Rio Bravo, Rio Manso, or Rio Nuevo. Have them decorate their cake appropriately. A spokesman for each team then tells the rest of the class what they put on their river model. Then have a party and eat the cakes!

Have students draw the three rivers on their own. This could be done at the end of each section (Rio Bravo, etc.)

Have students write about the differences between the rivers, what changes have occurred and what is being done to protect and restore the ecosystem today.

Extensions: Until relatively recently, flooding in the Rio Grande Valley was a common and often devastating occurrence for human settlements. The math worksheet “How Long Ago?” on page 189 will help students realize that floods occurred in the Albuquerque region in the not too distant past. Make a copy of the worksheet for each student. Have students subtract the year for each event listed from the current year to determine how long ago these floods occurred.

Have students pay attention to the news for items related to the bosque and the river. There are many issues that regularly appear in the news: endangered species, water planning/water sources, fires, clean-up activities, etc. Post newspaper items in the classroom; have students report on the news they have heard to the rest of the class.

An additional activity about invasive plant species can be found in: *The Watercourse*. 2001. *Discover a Watershed: The Rio Grande/Rio Bravo*. Bozeman, Montana: The Watercourse. “An Invited Guest, that overstayed its welcome,” p. 259.





Adapting to Other Grades

For younger primary grades, do a felt-board example of the basic items that are part of the bosque—a river, cottonwood trees, sand bar, etc. before working with a model of the river. Place a velcro dot on River Model pieces for use on the felt board.

Discuss what trees need to live (besides sunlight, soil, carbon dioxide)—they need to have water, we water the trees at school and home. In the bosque their roots must reach the water in the ground.

What animals live in the valley? Think of the needs of ducks and cranes they might see along the river—they need the extra water of the valley.

Research: Have the students research the animals that live in the bosque. Put together a book or poster about the animals. Use these projects to teach younger students.

Have older students learn the “Changing River” activity and then teach younger students using the model.



cottonwood catkins
(male, left, and female)
Photos by Nolan Hester

