13. *Changing River*

The Base Activity for the Middle 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, jetty jack, 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 on pages 179–188 or kit materials from workshop
2. five copies of model components (pages 177–178) or kit materials

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
5	grassy meadows
15	riparian native shrubs
15	upland shrubs

After alteration (Rio Manso):

20	houses or other buildings
20	jetty jacks
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	dam
10	additional mature cottonwood trees
5	additional upland shrubs

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):

3. 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
4. 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.

5. two brown ribbons or thin fabric strips for levees, 8 feet (2.4 meters) long each
6. 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.)
7. green and brown construction paper or felt for agricultural fields, various sizes (long, narrow for ditch-served fields, rectangular or square in some areas), varying from 2 to 5 inches (5 to 12.5 cm)

Options on kit development: If you are creating your kit from the masters in this activity, you can have students color the components with crayons, paint, etc., and possibly laminate them before cutting them out. You might want to ask students to make their own model components from scratch using felt or construction paper. You may also want to use actual materials gathered from the bosque—using leaves to represent plants, gluing sand to paper for sand bars, sticks for stems, etc.

Note: A chart showing the number of model pieces needed for each river scenario follows.

Note: Participants attending a Bosque Education Guide workshop receive color-coded, laminated model components. Complete kits for doing this activity are also available to borrow from the Rio Grande Nature Center in Albuquerque. Otherwise, kits can be created using the model component pages in this activity.

(Note: Flower and cottonwood photographs in this unit are from New Mexico Museum of Natural History collection and photos of the Rio Grande are courtesy of the Friends of the Rio Grande Nature Center.)

"Changing River" Model Pieces

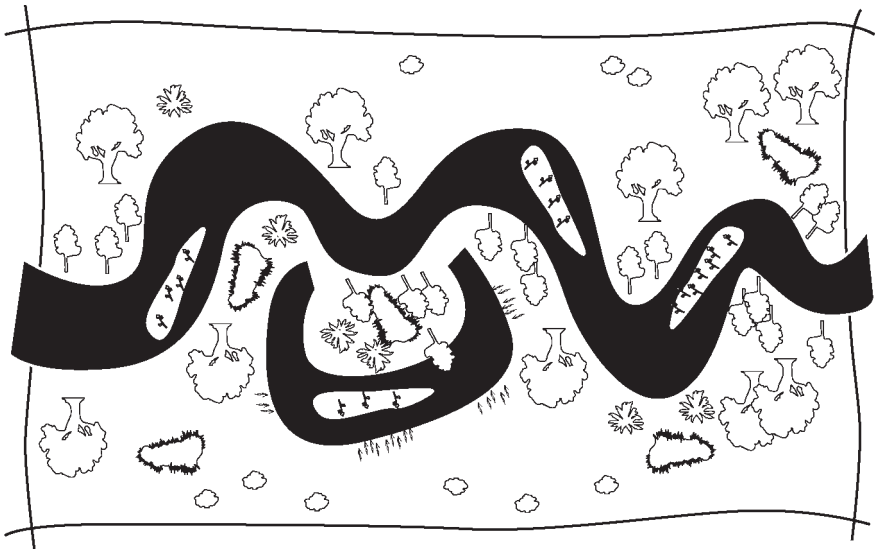
What to Have on the Model When

	Rio Bravo	Rio Manso	Rio Nuevo Summary	Habitat Restoration Projects								
				Overbank Flooding	Pole Planting	Wetland construction	Fuel-wood reduction	Secondary channels	Exotic species removal	Water conservation	Jetty jack removal	Monitoring along river
Cottonwood seedlings	100	10	75	10		5		40		5	5	
Cottonwood saplings	20	1	11		10							
Mature cottonwoods	10	20	20	1	1		-1	1	1		-3	
Cattails	100	5	73			50		10		5	3	
Sand bars	5	2	4					2			1	
Grassy meadows	5	1	4				1		2			
Riparian shrubs	15	7	13	2		1	1	2				
Upland shrubs	15	20	15	-1		-1	-1	-1	-1			
Houses	–	20	19	-1								
Jetty jacks	–	20	12					-3			-5	
Exotic species	–	30	11	-1		-1	-5	-1	-10		-1	
Snags	–	10	5	-1			-4					
Irrigation ditches	–	2	2									
Levees	–	2	2									
Agricultural fields	–	10	10									
Dam	–	1	1									
Monitoring plots	–	–	6									6

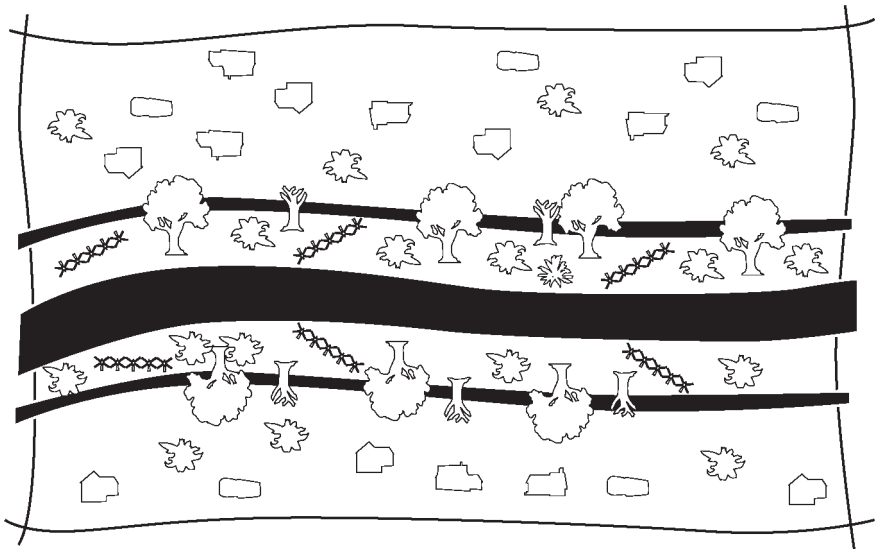
Background: This activity builds a model of a section of the Middle Rio Grande Valley. Models are tools that help us understand complex systems by simplifying their components. We use models to help demonstrate ideas that are not as easy to grasp when working with a real ecosystem.

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.

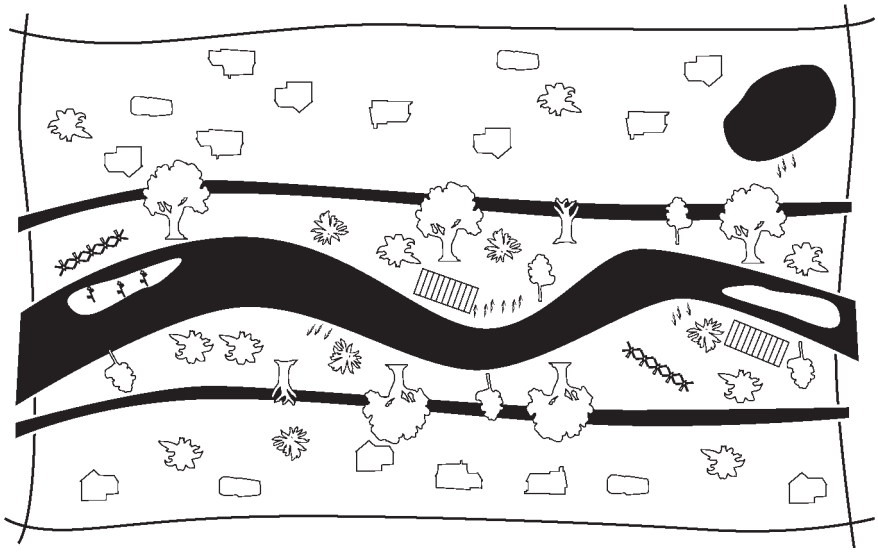
In contrast, we call the river that has been highly altered by humans ***Rio Manso***. *Manso* is a Spanish word that means tamed, such as a horse that has been broken to riding. For many years, changes were made to the river system with the top priority being how the river was serving the human society. 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


oxbow

meander or bend in the river**:** the manner in which a river bends or curves

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


meander

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


braid

(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.*

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 represented 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.

evening primrose

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

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: Time Line for the Historical Rio Grande

Here is a time line for making the transition from Rio Bravo to Rio Manso. (The dates are taken from Appendix D: Human Chronology). Items with ✓give instructions for making changes to the model. This time line addresses the valley between Cochiti Dam and Elephant Butte, so it may need to be adapted for other locations.

2,000 years before present: The first agriculture was practiced here in the Southwest, mainly people planted seeds along upper canyons and washes and waited for rain to provide moisture for them to grow.

✓*add one small agricultural field*

450 AD: First permanent settlements along the Rio Grande; corn was primary crop.

✓*add one pueblo-style house*

1275–1300 AD: 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 population of the valley increased. The people grew corn, beans, squash and melons.

✓*add another pueblo-type house*
✓*place a few agricultural fields*

1600s: The Pueblo people consolidated into a few villages; the abandoned areas were colonized by Spanish settlers.

✓*add four more houses along the river*

1706: Albuquerque was founded.

1880s—: Large floods occurred in 1874, 1884, 1891, 1903, 1909, 1912, 1920, 1937 and 1941. There had been overgrazing in the hills; water sped off the land to the valley. There were few plants to hold the soil and slow the flow of water. Sediments filled the river channel. The water table of the valley was very high with standing water—fields were flooded and did not drain.

1885: A dike was built to protect "New Town," Albuquerque's downtown area where the new railroad had just been built. There was a lake in Los Ranchos for a month, but the soil was left enriched.

✓*add five more houses*
✓(option) *use levee material doubled up to build "small dike"*

1925: The Middle Rio Grande Conservancy District was formed to provide irrigation, drainage and flood control for the valley. Deep ditches called drains or clear ditches were built to remove standing water from farm fields. Levees were built for flood control.

✓*place levees along each side of the river on the model. You should straighten and narrow the river as you do this.*
✓*add the longest irrigation ditches just outside of the levees*
✓*add more agricultural fields*
✓*remove about 95 cattails showing a decrease in marsh areas*

1930s: Saltcedar/tamarisk spreads through the valley.

✓*add introduced riparian shrubs and exotic trees*

1941: The levee was breached for the last time that century, and there were two months of standing water in town. If you walk between the levee and the river at the Rio Grande Nature Center many of the cottonwood trees you see sprouted during that 1941 flood year.

1957: There were major efforts to control the river after World War II. The levees were improved and protected by Kellner jetty jacks.

✓*add jetty jacks to protect the levees and keep the river in its channel*
✓a*dd the rest of the houses*
✓*remove about 90 seedlings, since lack of flooding means reduced natural regeneration; leave remaining seedlings on sand bars and immediately adjacent to river*

1975: Cochiti Dam was completed and began filling.

✓*add a dam at the up-river end of the model, or discuss that there is a dam up-river*
✓replace 19 cottonwood saplings with 10 additional mature cottonwood trees to show that no new tree recruitment is going on, but the trees in place are getting older
✓*remove three sand bars (Cochiti Dam traps sediment, so the water flowing through is clear until it picks up sediment from the channel downstream. This sediment scours the channel and decreases sand bar formation.)*

Some of the gradual changes since 1975:
✓*add the burned snags: there are more fires with more people living in the valley*
✓*add five more 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.*

At this point, you may want to proceed on 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 channels…

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)*
- *Jetty jacks between the river and levees to stabilize levees*
- *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*
- *Clumps of snags or burned trees within the bosque from human-caused wildfires (exotic shrubs are often underneath these snags)*
- *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. For one it would flood people in places such as Alameda, Corrales, Old Town, Downtown, etc. Also, it would be almost impossible to eradicate all of the introduced plants. Many 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. This is a lead into the next step: transforming the river to ***Rio Nuevo****.*

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 160), 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, jetty jacks, Russian olive trees, saltcedar stands, 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 187 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.

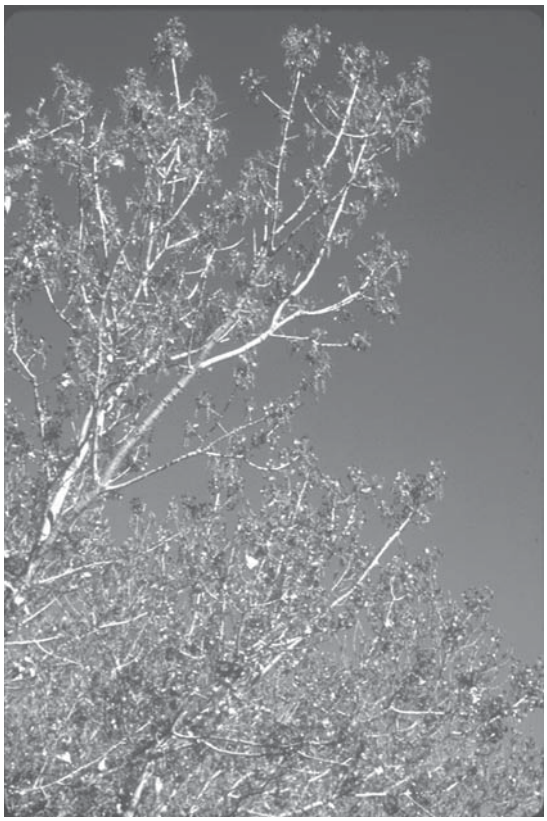
Discuss what trees need to live (besides sunlight, soil, carbon dioxide)—they need

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 tetones

Rio Bravo Information Cards

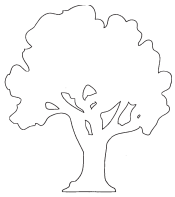
Cottonwood Seedlings —"baby" cottonwoods
(Populus deltoides ssp. wislizenii)
Small cottonwood trees which have just started growing. Generally, seedlings are less than 1" (2.5 cm) in diameter at 4.5' (1.35 m) from ground level. Habitat needs:
- *bare, wet soil to germinate*
- *open areas where there is a lot of sunlight*
- *roots must stay in water as the water table drops throughout the summer*
- *grows near water, on sand bars, near river's edge*

RIO BRAVO

Cottonwood Sapling—"teenage" cottonwoods
(Populus deltoides ssp. wislizenii)
Small cottonwood trees. Larger than 1 in. (2.5 cm) in diameter and less than 4 in. (10 cm) in diameter at 4.5 ft (1.35 m) above the ground level. Habitat needs:
- *roots must reach to water as the water drops throughout the summer*
- *in former high water area—not far from riverbank*
- *not along the edge of river*

RIO BRAVO

Big Cottonwood—"mature" cottonwoods
(Populus deltoides ssp. wislizenii)
Mature Rio Grande cottonwood trees can be up to 80 ft (24 m) tall and 4 ft (1.2 m) in diameter. Habitat needs:
- *usually not near current river channel (trees survived because the river changed location after the trees were established)*
- *in the flood plain, not on valley slopes*
- *roots must reach to permanent water table*



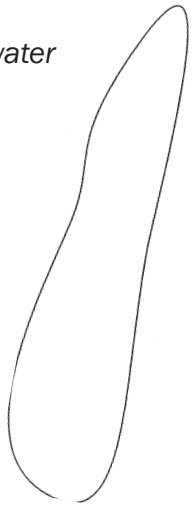
RIO BRAVO

Cattails (Typha sp.)
These wetland plants represent marshes and are are important areas for wildlife nesting, protection and food. Habitat needs:
- *there must be water at the surface for most if not all of the year*
- *often at an oxbow—an old channel of the river*
- *occasionally on the edges of sand bars or the inside curve of meanders*

RIO BRAVO

Rio Bravo Information Cards

Sand bar
Sand bars form in areas of the river where the water slows. Sediments, such as sand, drop out of the slowly moving river. Place:
- *in the river channel or along the edge of the river*
- *lengthwise, with the flow of water*



RIO BRAVO

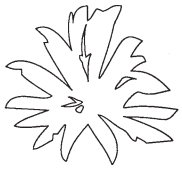
Upland Shrubs
Upland shrubs grow in dry places where the water table does not come near the surface. Habitat needs:
- *live in higher areas*
- *depend on rain for moisture*
- *can live on very little water each year*

Examples: fourwing saltbush, fringed sage, broom dalea/false indigo

RIO BRAVO

Native Riparian Shrubs
Native shrubs have lived here for thousands of years. Habitat needs:
- *in the flood plain of the river—the lowland alongside the river*
- *in the shade under old/mature cottonwoods*
- *sand bars*

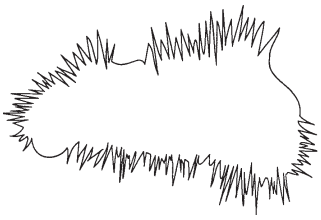
Examples: New Mexico privet/ New Mexico olive, silverleaf buffaloberry, coyote willow



RIO BRAVO

Grassy Meadow
Grasses are one of the largest families of plants, providing seeds, leaves, and roots as food for many rodents, insects, and birds; and shelter for birds, insects, and rodents
- *Different species grow in many environments from dry uplands to wet marshes, in full sunlight or in forest shade*

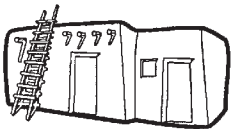
Examples: saltgrass, blue grama



RIO BRAVO

Rio Manso Information Cards

Houses
People moved into the area.
• place houses where you would want to live



RIO MANSO

Agricultural Fields
Include gardens, orchards, cropland and pastures.
• place in the flood plain of the river
• you may need to clear land for your crops
• orient long, narrow fields with the short side next to a ditch

RIO MANSO

Irrigation Ditches and Drains
Irrigation ditches and drains move water to agricultural fields and back to the river
• place drains outside of and parallel to the levees
• irrigation ditches should run from the river to the fields
• remember that water flows downhill

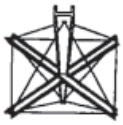
RIO MANSO

Levee
A levee is a raised embankment running parallel to the river. This high berm keeps the river confined in high water, and protects areas beyond from flooding.
• place parallel along the entire length of the river
• place on both sides of the river
• narrow and straighten the river—confine it to a narrow channel

RIO MANSO

Rio Manso Information Cards

Jetty Jacks
These are giant metal frames the same shape as the pieces in the game of jacks—held together by thick cables. They were designed to protect the levees from being washed away by the river.
The river is narrowed and straightened by this process—confined to a narrower channel.
Place:
- *some between the river and the levee, on both sides of the river*
- *some parallel to the river's edge*
- *some perpendicular to the levee, angling downstream*



RIO MANSO

Exotic Riparian Trees
Non-native, exotic trees were brought here by people; most species were introduced in the last 100 years.
- *place in the flood plain of the river—the lowland alongside the river*
- *may grow in the shade under big cottonwoods.*
- *often grow in openings, such as after a fire*

Examples: Russian olive, saltcedar or tamarisk, Siberian elm, tree of heaven

RIO MANSO

Burned Snags
Snags are standing dead trees. Many are created by fire. Most bosque fires are started by people, and fires have increased since humans settled in the area.
- *place in bosque between river and levee*

RIO MANSO

Dam
Place (or imagine) a dam at the upper edge of the model
- *it will cross from one edge of the flood plain to the other—from upland to upland across the river*
- *it will totally control the flow of the river—water will be released under specific conditions*
- *catastrophic flood will now be controlled—the spring runoff will be reduced and the summer flow will be increased as water held behind the dam in high flow will be released in times of lower flow*

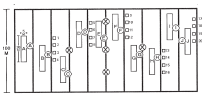
RIO MANSO

Rio Nuevo Information Card

Monitoring Plots

Resource managers need to monitor the results of their actions, and monitor the bosque in general to understand what changes are happening:

- select sites where you want information about what is happening in the bosque
- select some sites that have not been disturbed
- select some sites where restoration projects are installed

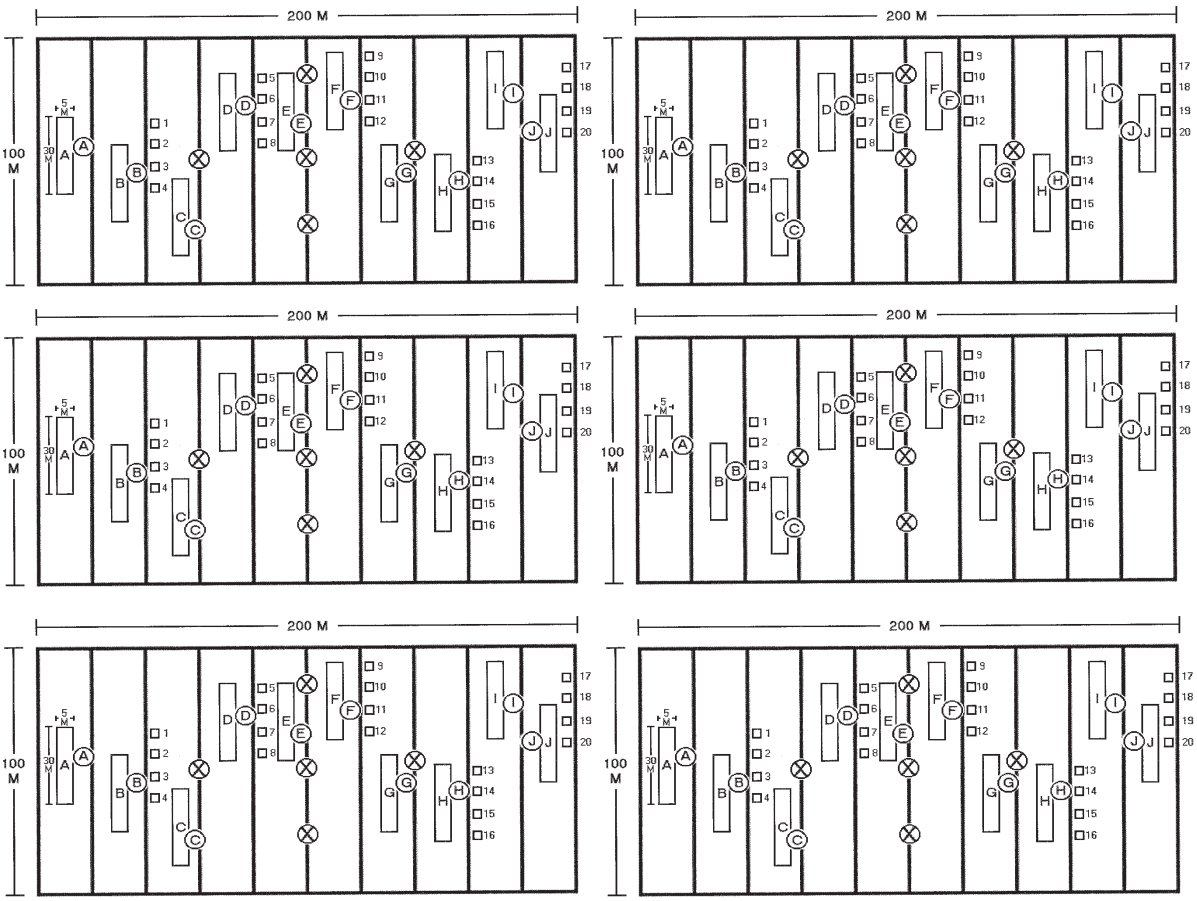


RIO NUEVO

About the monitoring icon:

The icon used to represent monitoring plots is a diagram of a study plot from the Bosque Ecosystem Monitoring Program (BEMP). BEMP is only one kind of monitoring study and other studies may have different designs. BEMP plots are 100 meters by 200 meters and are oriented lengthwise parallel to the river. Each plot contains 10 vegetation plots (the long rectangles), five ground water wells (circle with an 'x'), 10 litterfall tubs (circle with letter), and 20 pitfall traps (small squares). The plots also have two rain gauges and three temperature data loggers but these are not pictured on the icon.

Rio Nuevo Model Pieces (make one copy and cut into six plots)



Rio Nuevo Habitat Restoration Project Cards

Overbank Flooding

During years with a high winter snowpack there will be lots of water melting and flowing down the watershed in the spring. Much water will be held in reservoirs for irrigation through the summer, but in good years a large flow can be allowed downstream during the normal season for spring runoff. The water managers at the Army Corps of Engineers and Bureau of Reclamation can decide to allow for water amounts to pass through the dams that will spill over the banks of the river and flood some of the floodplain of the Rio Grande. This is called "overbank flooding." (The goal is to have standing water in wooded areas within the levees. This way the communities outside the levees are protected from flooding.) Overbank flooding promotes the growth of mature cottonwoods and other native riparian plants as well as encouraging the natural cycling of nutrients.

What beneficial changes will there be as the result of this project? What habitat components can we replace on the model now?

- ✓ place ten more cottonwood seedlings on the model; seedlings can be added to sand bars or edges of the river or to places that have been cleared of other vegetation
- ✓ place two more native riparian shrubs on the edges of the Rio Grande; plants such as willows will grow well now
- ✓ remove one upland shrub: wetter areas are no longer attracting upland plants
- ✓ if any homes have been placed within the levees, remove these now: floodplains are a silly place to build anyway
- ✓ remove one snag: with overbank flooding fuels are reduced by faster decomposition and less likely to burn with wetter conditions
- ✓ remove one exotic tree as conditions are not as optimum for some of these plants

Pole Planting of Cottonwoods

The numbers of cottonwoods are decreasing along the Rio Grande, because for decades flooding has been prevented and natural places for cottonwood establishment are not being created. One way to counteract this is to plant cottonwoods. Cottonwoods have an adaptation that land managers can take advantage of: a long, young branch of a cottonwood tree (here called a "pole") can be cut and put in the ground where it will send out roots and grow. We can have tall trees immediately, without needing to grow them in a nursery from seed. This usually takes a lot of labor, a giant drill to drill a hole down to the water table (remember cottonwoods need to have their roots in the water to survive), and very long branches of cottonwood, 15 to 20 feet long (and even then, all but a few feet will be buried). The cottonwood pole is slipped in the newly drilled hole and dirt is packed in. This is a way to give some cottonwoods a good start, but it is expensive, especially if you are looking at miles of river needing more cottonwoods.

What beneficial changes will there be as the result of this project? What habitat components can we replace on the model now?

- ✓ add ten more cottonwood saplings to the model, making sure you put them close to the river where the water table is not too deep
- ✓ add one more mature cottonwood tree to symbolize that this project will mean large trees in the future

Wetland Construction

The numbers of marshes and wetlands have been reduced over the last decades. Managers can create new ponds and wetlands. Some examples are the ponds at the Rio Grande Nature Center, at the Bosque del Apache National Wildlife Refuge, and southeast of the Alameda bridge over the Rio Grande in Albuquerque. A different wetland is a "constructed wetland" that takes wastewater and sends it through a series of small water pools. Each pool is filled with cattails and other plants that clean the water. Constructed wetlands can be found at Los Padillas Elementary School in Albuquerque and at Los Ranchos de Albuquerque village center.

What beneficial changes will there be as the result of this project? What habitat components can we replace on the model now?

- ✓ place 50 more cattails on the model in groups representing 10 new constructed wetlands
- ✓ add five cottonwood seedlings (although wetlands are not specifically designed to recruit new cottonwoods, they often provide a good site for cottonwoods to reestablish)
- ✓ add one native riparian shrub: conditions are better for native plants such as willows
- ✓ remove one upland shrub: wetter areas are no longer attracting upland plants
- ✓ remove one exotic tree as conditions are not as good for some of these plants

Fuel-wood Reduction

In earlier years, the overbank flooding that would occur every few years would saturate the branches and leaves that had fallen on the ground in the bosque. By being wet, they would decompose more quickly than they have in recent decades. Microscopic organisms such as bacteria and fungi break down plant material into nutrients that can be used by other plants; this is called nutrient cycling. Prior to the regulation of the river, the cottonwood forest did not burn as hot as is does today—sometimes it was so wet that fuel wood on the ground decomposed fairly quickly. Since the elimination of overbank flooding after large dams were constructed on the river, fuel wood has built up on the floor of the cottonwood forests and everything is much drier. Fires spread very quickly once they get started and generally burn hotter and longer in the same area. Most fires are caused by careless people, and there are many more people living in the valley today. The fires burn far and wide. One way to reduce the destructiveness of fire in the bosque is to clean the area of downed trees and branches—reducing the fuels that create destructive fires. Teams of volunteers can haul away branches and sticks; a shredder can be used to create mulch that will decompose more quickly than large branches.

What beneficial changes will there be as the result of this project? What habitat components can we replace on the model now?

- ✓ remove four snags: as we control the fuel in the forest, fires will be smaller and less severe
- ✓ remove five exotic trees: much of the excess trees removed in these projects are non-natives
- ✓ remove one upland shrub; again we can select to remove shrubs like one-seed juniper
- ✓ add one native riparian shrub; while removing exotic and upland plants we are making room for native riparian shrubs
- ✓ add one grassy meadow: fuel breaks create more grasslands
- ✓ remove one mature cottonwood: sometimes we do need to cut some cottonwood down to make an effective fuel break

Rio Nuevo Habitat Restoration Project Cards

Creation of Secondary Channels

The river used to have many channels as it flowed down the valley. Some would only have water in them during the spring runoff, but this was enough for cottonwoods to get a good start. In some areas, the easiest way for cottonwoods to get established is for us to help out nature a little. In places where the banks are just too high, managers can take in a bulldozer, lower the bank, and create a small side channel where water will flow some times of the year. Cottonwoods and native shrubs such as willow can get established here. Sediment removed from the banks can be returned to the river, creating new sand bars and improving Rio Grande silvery minnow habitat. An example of this is on the west bank of the river south of Bridge Street in Albuquerque (the Albuquerque Overbank Project). Many young cottonwoods have now reached the sapling stage after their human-encouraged head start.

What beneficial changes will there be as the result of this project? What habitat components can we replace on the model now?

- ✓ add 40 cottonwood seedlings; these projects are prime habitat for germinating cottonwoods
- ✓ add one mature cottonwood tree to represent the future forest
- ✓ add 10 cattails to show more wetlands being developed
- ✓ add two sand bars below the project site, created by sediment added by the earth work
- ✓ add two native riparian shrubs: birds like willow flycatchers need thickets of willows to nest; these thickets have been rare for many years, and now more are being created
- ✓ remove one upland shrub because the habitat no longer provides dry conditions these plants need
- ✓ remove three jetty jacks
- ✓ remove one non-native tree

Removal of Exotic Species

Many agencies and landowners are involved in reducing the number of introduced species such as saltcedar (also known as tamarisk, *Tamarix chinensis*), Russian olive (*Elaeagnus angustifolia*) and Siberian elm (*Ulmus* sp.) in the bosque. These exotic shrubs and trees are increasing, in general, because human-caused changes in the river valley provide favorable conditions for them to grow. Saltcedar has been thriving, especially in the lower Middle Rio Grande Valley. Saltcedar trees flower and produce seeds throughout the growing season; their reproduction is not restricted to spring/early summer as are native cottonwoods. When bare ground is colonized late in summer by saltcedar, it will not be bare in the spring when cottonwoods are sending out seeds. Both Russian olive and Siberian elm can sprout in shaded areas, under the canopy of the cottonwoods and are becoming very common in the bosque. Entire food chains depend on the cottonwood trees of the bosque. As cottonwoods are crowded out by introduced species such as these, the entire ecosystem is affected and fewer native species thrive.

Large saltcedar removal efforts have been undertaken at the Bosque del Apache National Wildlife Refuge. They have experimented with different procedures to effectively keep the saltcedar from returning. Santa Ana Pueblo has also undertaken major projects to restore the bosque to its previous native-species-only state. The bosque near Tingley Beach in Albuquerque is a showplace contrasting a restored area to the invaded area. This work can range from volunteers cutting down and removing exotic trees to the large equipment of bulldozing and repeated rootplowing, sometimes using herbicides to reduce their reoccurrence.

What beneficial changes will there be as the result of this project? What habitat components can we replace on the model now?

- ✓ remove 10 exotic trees
- ✓ remove one upland shrub in the flood plain (we can select to remove shrubs like one-seed juniper during these projects)
- ✓ add two grassy meadows: removing exotic species provides space for more grasslands
- ✓ add one mature cottonwood: as exotic species are removed there is room for our native trees

Rio Nuevo Habitat Restoration Project Cards

Water Conservation

The amount of water that is used by people along the river has an impact on the health of the bosque and river life. Pumping more water than is replenished through infiltration each year causes the water table to drop; plants that depend on ground water can no longer reach their roots to that depth and die. When the water table is lowered, more river water will soak down into the ground, leaving less flow on the surface — less water for all of the users who need water. Some New Mexico communities use river water for their household water supply. The more water taken from the river, the less is available for the plants and animals that have evolved to depend on that water. Though some water will be returned to the river after passing through a sewage treatment facility, much is used, evaporates or returns to ground water. The City of Albuquerque had used only ground water for its water supply for many decades, though they owned the rights to Rio Grande water, referred to as surface water. As the population increases and water use increases, the City plans to remove and clean Rio Grande water and include it in its water supply. Water will be returned, but the flow level in the Rio Grande will be reduced—affecting life below the pull-out area. We can lessen the need to lower the flow of the Rio Grande by reducing the water we use: plant low-water using landscaping, install low-flow toilets, turn off the water while brushing your teeth, take shorter showers, etc.

What changes will there be as a result of this water conservation project? What habitat components can we replace on the model now?

- ✓ add five cottonwood seedlings: with more water in the river, more places can flood and start new trees, and seedlings can be added to sand bars or edges of the river
- ✓ add five cattails: more water in the river means more wetlands

Jetty Jack Removal

The Kellner jetty jacks were placed up and down the river, starting in the 1950s, to straighten the river and protect the levees. The jacks slow the flow of water so that sediment drops out and builds up and eventually plants can grow. This helps keep the bank of the river in one place. As a result, the straighter and more narrow channel helps make the water flow downstream more quickly. The jacks also help to protect the levees. Today, the river banks and levees are quite stable, and the jacks are seen as eyesores. Several management agencies are removing jacks from the bosque. In addition, managers now realize that a stable river bank is not desirable in terms of benefitting the bosque—the banks need to be able to move again. In addition to removing the jacks, managers can destabilize and lower the river bank in certain places to promote flooding and to restore sediment to the river. All of these may improve habitat for silvery minnows and other species.

What beneficial changes will there be as a result of this project? What habitat components can we replace on the model now?

- ✓ remove five jetty jacks from the model
- ✓ remove three mature cottonwood trees as trees sometimes are removed in the process
- ✓ add five cottonwood seedlings as the river can meander more and create new sites for cottonwood regeneration
- ✓ add three cattails as the river can be more braided and provide more wetlands
- ✓ add two sand bars below the jetty jack removal project
- ✓ remove one exotic tree (exotic trees like Russian olive often grow within the jetty jacks and are removed with them)

Rio Nuevo Habitat Restoration Project Cards

Monitoring

An important part of managing the bosque is to understand what is happening to the plants, animals, water table, and other ecological functions in the bosque. The process of collecting, compiling, and analyzing information is called "monitoring." Monitoring is an essential tool for land managers to understand if their actions are making any changes (good or bad) in the ecosystem. Many agencies responsible for caring for the river and the bosque collect data on a regular basis. Some schools also help collect important data. In addition to measuring the water table, weather factors, and soil factors, students also collect information about plants and animals.

Why is it important to collect information about the bosque over the long term? How can this information be used to help manage the bosque?

- ✓ add six monitoring plots to the model. Carefully choose places you wish to monitor. You may want some sites that have not been disturbed by recent activities. You might also want some sites where you have done projects.

Note: The monitoring icon is an image of a Bosque Ecosystem Monitoring Program (BEMP) plot. These sites are scattered throughout the Middle Rio Grande Valley and are generally monitored by students from Grades 2–12.

How Long Ago?

Rio Manso Math Exercise

When	What	How long ago? This year minus:
1884	One of the worst floods in the history of the Rio Grande. Alameda Dike is started. Flood is kept out of Albuquerque's Old Town.	- 1884 =
1885	Alameda Dike is iimproved and flooding of New Town is prevented once again.	-1885 =
1904	Water breaks through a dike. Los Ranchos area becomes a lake.	-1904 =
1925	Standing water is drained and levees to control the river are being built.	-1925 =
1941	Flood waters go over and through the levee. Last large crop of cottonwoods gets its start.	-1941 =
1957	River is made to stay in one channel by-levees, jetty jacks and natural boundaries.	1957 =
1975	Cochiti Dam is finished. No more serious floods are likely.	1975 =