

Chapter 3

Going Out: Field Activities

Activity Number		Page Number
	Planning a Bosque Field Trip	59
1.*	Bosque Field Journals	63
2.*	Signs of Humans – Scavenger Hunt in the Bosque. 78	
3.*	Naturalist Notebooks	88
4.*	Wildlife Detectives	101
5.*	Crawly Creatures	107
6.*	Dip Net Critters	115
7.*	A Rose By Any Other Name	122
8.*	Reading the Bosque	133
9.*	Winter Buds	153
	NGSS Connections to <i>Going Out: Field Activities</i>..	164

*NM STEM Ready! / Next Generation Science Standards (NGSS) aligned



Planning a Bosque Field Trip



Riparian forests are magical places. This rare and endangered ecosystem is unlike most of our arid state, so just entering the forest can be unlike anything students have previously experienced. In order to understand the complexity of the bosque ecosystem, students must first gain an appreciation for its diversity and for the uniqueness of this valuable habitat. The *Going Out* activities in this section encourage students to explore and discover the hidden, and not-so-hidden, secrets of the bosque and adjacent wetlands. In doing so, particularly with repeated exposure, students develop a sense of belonging to the bosque that will encourage them to want to learn more about its science and to support its protection. They develop a sense of place.

We encourage you, if at all possible, to take regular trips to the bosque or other natural area. This might be monthly, or once per semester, but the more frequent the better. These activities are designed to promote observation skills. They focus on discovery and exploration, and some include more advanced skills of data collection and analysis, and plant and animal identification. They can also be used to address Common Core / ELA Standards.

If you can only do one activity in this section, we encourage you to try *Bosque Field Journals*. As you will see in the background to that activity, there are numerous benefits to using field journals on a regular basis, and they can be used to address Common Core / ELA standards as well as science standards. They can be combined with science journals and /or writing journals, and can become part of your daily schedule. Field journals can be used in the bosque, in other natural areas, or on your school campus. We urge you to make them a regular part of your syllabus!

Successful field trips to the Rio Grande bosque depend on pre-planning. Here are recommendations and tips.

Practical Field Trip Tips for Educators

- It helps to have a colleague join you for your first trip out, or plan to take combined groups with older and younger students working together.
- Ideally, plan on one adult (teachers, aides, parents) per 4-5 students. Extra adults help with safety, can be assigned small tasks and can help students with prompts. Provide specific guidelines for how chaperones can help students. Parents always enjoy their time outside!
- Make reservations with the agency to be visited for the field trip. Discuss with agency contact the purpose of field trip, and clear lunch or snack plans.
- Complete individual school or district permission forms for field trip.
- Arrange transportation.
- Give informational letters to parents—include list of items for students to bring and an overview of the trip.



- Make a pre-trip visit to the site of field trip to be familiar with the area and to prepare student activities. Scout out places to go that will allow your class to break into smaller groups of 4-5 students while still staying on the trails. For example, intersections of trails allow groups to go in several directions while remaining close by. Utilize picnic areas, outdoor classrooms, or other space designed for group use.
- Prepare *Bosque Education Guide* activities.

Things to Bring on a Field Trip

1. As appropriate, younger children should be clearly labeled with first name, school name and telephone number.
2. Dress for the weather. Winter weather requires a water bottle and, as a minimum, a jacket; hat and gloves are recommended. Summer weather requires sunscreen, hat, water bottle and insect repellent. Long pants and sleeves protect against insects and bosque shrubs; however, students should remain on trails away from most hazards. Shoes during any season should be sneakers or boots. Sandals are not appropriate for trail walking.
3. Water should be available in any season.
4. Educators should have the paperwork required by their school for field trips, including emergency contact numbers, in their possession.
5. Each student should wear a backpack to carry journals, pencils and other journaling supplies, water bottles, lunch, extra clothing, etc. This allows hands to be free for exploring and also prevents items from being dropped and lost somewhere along the trail.
6. Bring (and use) a litter bag.
7. Bring cameras, binoculars, field guides.
8. Bring a first-aid kit, but know your school's rules on liability.
9. A small dry-erase board, marker and tissues are helpful to use in the field to write journal information, show how to set up columns or horizontal rows, show spelling, etc.
10. Use established picnic areas where available for lunches, but it is ok to sit on the ground to eat lunch as well! It is good for students to become comfortable eating outside. Always be sure to leave nothing behind when you leave; even small pieces of food should be picked up. Remind students that human food is not always good for animals to eat.



Review Rules and Expectations

Students need to understand that they are visiting another creature's home and should treat it with respect. In addition to your personal class rules for discipline, you should encourage the following:

- Use walking feet and quiet voices so as not to disturb animals.
- When students find something that they want to share, let them do so but please return everything (except trash!) to the place where they find it. A good rule is to allow students to pick up insects (within reason) and things that are "dead, down and on the ground." Point out that many organisms (including animals, plants, fungi) live in the bosque and that you are visitors in their home. Everything belongs there and should be left, whether it is a rock, a feather or a piece of bark. An exception is with the "Find a Friend" prompt; students may carry their friends around while in the area, but be sure to return friends before leaving.
- Be gentle with any creatures you might pick up. Please discourage squashing spiders or stepping on ants; remind students that these creatures are living beings just as we are, and are part of the ecosystem. Note that handwashing is important before touching living creatures, particularly amphibians as they are especially sensitive to chemicals found in mosquito repellent, sunscreens, etc.
- Please do not pick living plants, and take care not to trample plants when walking (stay on trails as much as possible).
- These activities encourage exploration, but safety should also be a concern. There are areas of the bosque where students can get disoriented and lost. Set boundaries for exploration, such as "You must stay between this road, the jetty jacks and the river" or "within sight of the teachers" or "behind one teacher and in front of another."
- Practice "Leave No Trace" principles.

Destination Options

There are many places to get to the bosque and take a walk. Maybe there is great access just down the road from your school!

But, if you are looking for some additional resources such as rest rooms or facilitators with field equipment to use, here are some examples:

Bachechi Open Space, Bernalillo County

Bosque del Apache National Wildlife Refuge, Socorro County

Rio Grande Nature Center State Park, Albuquerque,

Valle de Oro National Wildlife Refuge, Bernalillo County

Whitfield Wildlife Conservation Area, Valencia Soil and Water Conservation District, Belen



Going Out – Fun Facts

There are many interesting things to discover in the bosque. Here are some fun facts to share with students about things they may find:



Chewed leaves are mostly chewed by arthropods, including insects and isopods (pillbugs and woodlice). Isopods, now the primary detritivore (dee-TRY-ti-vore; eater of dead plant or animal material) in the bosque, were introduced into this ecosystem from Europe!



Cottonwood cotton is the seed of the cottonwood tree. The fine cotton-like fibers surrounding the tiny seed allow the wind and water to transport the seed. Cottonwood trees are either male or female. “Cottonless” cottonwood trees are male trees. They produce pollen from long, red clusters of flowers (called catkins). Only female trees produce seeds; the developing female catkins are locally known as tetones and resemble peas until they open. Cottonwood seeds or cotton “fly” in late May or June, but old cotton can be found year-round under logs or in crevices.



Rolled leaves are created by a caterpillar for its home. The caterpillar eventually becomes a small moth. They can be hard to find!



Star twigs: Have students pick up a cottonwood twig from the ground. Find a terminal bud scale scar (See “Winter Bud Activity” for an illustration). It looks like a ring or collar that circles the twig. Snap the twig in two at this point. Look at the star shape formed by the pith of the twig, the cells in the center of the stem.

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1.

Bosque Field Journals

Description: Students participate in ongoing, active discovery and exploration experiences guided by search cards or prompts that help them engage with their natural surroundings, and they record observations of what they find. Ideally, Field Journals are used during repeated outings to the bosque or other natural areas.

Objectives: Bosque Field Journals will:

- introduce students to the bosque environment, best if over many, repeated visits;
- enhance observational skills, sensory awareness, feelings and connections with the bosque through writing, drawing and thinking about the bosque; and
- encourage an excitement for learning more about the bosque through active, guided explorations.

Phenomena: The bosque (or other natural area) contains a variety of interesting things that may be discovered by careful observation. Recording my observations helps deepen my understanding.

Lesson Questions:

- *What interesting things can I discover in the bosque (or school yard) today?*
- *What changes in the plants and animals can I observe with repeated visits to the bosque or other natural area?*

1. Bosque Field Journals



Grades: K–5 (and older)

Time: Pre-outing prep with students: 15 minutes. Class activity: flexible. This can be done as a field trip, requiring time to plan your destination, plan transportation, etc., but also can be done in the school yard. Allow 15 – 60 minutes (or more) for the activity itself when in the bosque or other natural area.

Subject: science, English, math, art, social studies

Terms: bosque, journal, observation, phenology. Additional terms vary depending on prompts chosen or opportunities that arise in the field.



New Mexico STEM Ready! / Next Generation Science Standards

NOTE: The exact standards addressed will vary depending on prompts, discoveries, or additional follow-up discussions selected. See **NGSS Connections to *Going Out: Field Activities*** at the end of this chapter for more possible field trip NGSS connections and for suggestions using each standard.

NGSS DCIs

K-2.ETS1.B Developing Possible Solutions
 K.ESS2.D Weather & Climate
 K.ESS3.C Human Impacts on Earth
 1.LS1.A Structure & Function
 1.LS1.B Growth & Development of Organisms
 1.LS1.D Information Processing
 1.LS3.A Inheritance of Traits
 1.LS3.B Variation of Traits
 2.LS4.D Biodiversity & Humans
 3-5.ETS1.B Developing Possible Solutions
 3.LS1.B Growth & Development of Organisms
 3.LS2.D Social Interactions & Group Behavior
 3.LS3.B Variation of Traits
 3.LS4.C Adaptation*
 3.LS4.D Biodiversity & Humans
 4.LS1.A Structure & Function
 4.LS1.D Information Processing
 5.LS2.A Interdependent Relationships in Ecosystems
 5.ESS3.C Human Impacts on Earth Systems

NGSS CCCs

Patterns; Structure & Function

NGSS SEPs

Analyzing & Interpreting Data; Constructing Explanations & Designing Solutions; Engaging in Argument from Evidence*; Obtaining, Evaluating & Communicating Information

Common Core Connections

English Language Arts:

Text Types & Purposes
 Production & Distribution of Writing
 Research to Build and Present Knowledge
 Reading Informational Texts*
 Vocabulary Acquisition and Use*

Mathematics:

Measurements
 Represent/Interpret Data

Geography:

Geographic Representations & Reasoning

*indicates extension activity

**Materials:**

- Field Journal for each student, which may be used for multiple outings to the bosque or other natural areas, including the school yard. A good option is spiral-bound Crayola sketchbooks with blank pages. These may be journals used in the classroom for science, writing, etc.
- Journal tools, such as pencil, colored pencils, charcoal or crayons for bark rubbings, etc.
- Optional materials for use in the field:
 - Thermometer
 - Compass
 - Small mats or “sit-upons” to give students a spot to listen, observe and draw/write
 - GPS device (for older students)
- Optional pages to glue into journals as the year goes on (see below for suggestions and masters)
 - Bosque Search Cards
 - Beaufort Wind Scale
 - Compass Rose to record wind direction
 - Cloud types
 - Tracks guide
- Materials for use back in the classroom:
 - Field guides for local plants, animals, tracks, rocks, weather, etc.
 - Computer access to online versions of identification guides.

Background:

“Field” or “nature” journals (either term may be used) provide ample opportunities for learning in a variety of subjects. Whether used for recording specific scientific data or general observations for later reflection, for writing prose or poetry while being inspired by nature, or for drawing or painting those observations directly, field journals offer endless possibilities. Field journals need not be an additional book; you might add to science journals or writing journals already used by your class. Field journals can be used to address many Common Core/ELA standards as well as science standards! Field journals are used by professionals as well as students, by scientists as well as authors and poets. An avian behavioral ecologist may record observations of bird feeding behavior observed in the field, while a hydrologist might record water table measurements taken from a groundwater well. Learning to make careful observations, and to record the information effectively, are good skills to develop not only for future scientists, but also for journalists, poets and artists.

Bosque Field Journals is more than a one-off activity; rather, it is intended to be an ongoing, semester- or year-long exploration. We encourage you to use nature



journals with your class on a regular basis, whether in the bosque or other natural area away from your campus, or simply in green spaces on your school grounds. Repeated, positive experiences with nature are shown to help students in numerous ways, from improving mental and physical health to increasing academic competency. Providing a prompt for exploration helps guide young students toward a meaningful interaction with the natural world. Recording their thoughts, observations and questions helps students to slow down and really notice the world around them. Revisiting those thoughts and observations back in the classroom, whether written in words or drawn in pictures, also provides students with an opportunity to delve deeper into topics of interest and to notice patterns in their data over time. Discovery and exploration of the natural world provide the first steps toward developing more specific, scientific observation skills.

Field Journals support the exploration of the phenology of a natural area. Phenology is the study of cyclic or periodic natural phenomena occurring in biological life cycles, and how these are influenced by climate and other components of the environment. Examples that your students may observe include the dates cottonwood (and other plants) flowers and leaves first emerge from buds, the date pollen and cotton are released, the date their leaves first turn yellow, and when the leaves begin to fall from trees. Others include the first butterfly sightings or the first sound of the cicada's buzz, the appearance of migratory birds or the timing of various stages of nesting activity. Any seasonal or periodic event is worth recording. Current data might be compared to similar records found online (such as through citizen science phenology projects, Budburst or Nature's Notebook), or your classes might begin a long-term data set that could be used by students for comparisons after several years. Such data sets are particularly important to monitor the effects of climate change.

Preparation:

- Field journals can be used in two ways; both are beneficial and complement each other so we encourage you to integrate both approaches into your schedule.
 - Schedule weekly, short outings (30 minutes) to a natural area on the school grounds for journal time. This might mean sitting around a single tree, or in a more vegetated area if available. This is a time for sustained silent writing, but with a simple prompt to direct attention such as Senses or Look Up / Look In-between / Look Down (see below, *Discovery Prompts*).
 - Schedule longer visits to an off-campus natural area monthly (or at least seasonally). Allow time for discovery and exploration, following prompts from the list below, and time to find a special spot to sit and write or draw about the prompt.
- Begin your outings early in the school year and continue on a regular basis throughout the year to study phenology (see *Background*). Regular outings will provide data for comparisons over time to detect patterns in weather conditions, observations of animal activity, the status of leaves on the trees, and so on. Comparisons may also be made between observations in the school yard and on field trips to natural areas.
- See *Planning a Bosque Field Trip* for specific field trip suggestions, including rules and expectations.



- **Practice the 5 S's of Nature Journaling:**
 - **Safety, Silence, Solo, Spread Out and Stay Put.**
 - Students should sit at least an arm's length apart but preferably farther; never sit directly next to someone else. Teachers must provide a good example and also spend the time journaling. Enjoy the opportunity!

Procedure: Part A – Going Out

♣ For each outing, whether to the bosque or other field trip, or simply to a natural area in your school yard, have students prepare their journals in the classroom, before going outside, by entering the following information:

- DATE
- TIME
- LOCATION (older students may include GPS coordinates)
- Space to enter TEMP (°F)
- Space to enter SKY conditions (clear, partly cloudy, overcast, type of clouds)
- COMPASS ROSE for showing WIND direction (glue in a copy)
- Space to enter WIND description
- Space to enter ANIMALS observed
- Space to enter PLANTS observed (This can be general, to compare what grows in the bosque vs in the school yard, or more detailed as students gain knowledge of local flora.)

♣ In addition to the above data, have students write at least one Discovery Prompt (see suggestions below) in journals while still in the classroom. For more complicated prompts, photocopy and have students glue them into their journals.

- For your first outing to the bosque, we suggest gluing photocopies of the “Bosque Search Cards” into journals (included below), so they will be available for reference all year. These cards are excellent for younger students, or other non-readers, but provide a helpful introduction to the bosque for older students as well.
- For subsequent outings, and for school yard outings, choose one discovery prompt from the list below; students should write the prompt into their journals.

Example of field journal page prepared in classroom by student and ready for field trip.



- ♣ For longer outings, once at the natural area, set boundaries for exploration. Then, allow students to follow their prompts. Keep in mind, however, that you never know what you will discover on any given outing. The students may find a porcupine, see a bird feeding its young, or encounter a giant web with a spider wrapping its prey. Allow flexibility to follow the students' interest when making new discoveries.
- ♣ After giving time for exploration, find an area where students can spread out and each can select a comfortable spot to sit and work in their journals, whether writing or drawing. Have students take out their journals and supplies when they settled. Be sure to fill in all of the data at the top of the page, as well as information about their prompt, and anything else of interest.
- ♣ Encourage students to write questions in their journals as well while in the field. The more time they spend outside really observing, the more questions they will have. Encourage their curiosity, and help them look for answers back in the classroom. This provides abundant material for research.
- ♣ Allow time to debrief. While still at the site, stand in a circle and have each person say one word about the place or habitat. Record if possible!

DATE: October 12, 2022 TIME: 10:15 am
 LOCATION: Rio Grande Nature Center
 TEMP: 72°F
 SKY: Clear, no clouds
 WIND DIRECTION and DESCRIPTION: Beaufort scale 2
 ANIMALS: Mountain Chickadee, Canada Goose, Ring-necked Puck (pond), Lizard, Butterfly
 PLANTS: Cottonwood, willow, Russian-olive, saltcedar

<p>See</p> <p>Cottonwoods Blue Sky Yellow and green leaves Lizard Butterfly - yellow and black</p>	<p>Hear</p> <p>Bird - a chickadee? Wind blowing leaves Dog barking My classmate talking A car horn</p>
<p>Smell</p> <p>Wet cottonwood leaves A skunk!</p>	<p>Touch</p> <p>Cottonwood bark is rough Saltcedar leaves - soft A smooth rock Damp soil</p>

Example of field journal page filled in during field trip.

Procedures: Part B – Back in the Classroom

- ♣ Back in the classroom, summarize observations from each outing on the board.
- ♣ Encourage students to ask questions and help them do research to find the answers.
- ♣ There are endless ways to use information from field journals to address ELA and Math as well as NGSS standards. Following are some examples. Be creative! You will find endless connections and opportunities.
 - Temperature: graph temperature data across the school year; convert between Fahrenheit and Celsius (**K.ESS2.D; Math Standards: Measurement**)
 - Make bar graphs / picture graphs of any of the information students are collecting (**Math Standards: Represent/Interpret Data**)
 - Look for patterns in observations. *Which plants or animals do we see all year? What things do we see only in some months? Why might we see some things during part of the year but not at other times? How does plant growth change across the year?* Record changes in a single species, such as cottonwoods (when leaf buds develop, when do the trees flower or release seeds, when do leaves grow, turn yellow/brown, fall to the ground). Use this as a way to notice seasons or temperature changes. For older students, discuss the concept of phenology (see *Background*). (**3.LS1.B; Patterns; Analyzing & Interpreting Data; Constructing Explanations**)



- Compare plants in the school yard vs in the bosque. *What grows at each location? Why might there be differences? Does this affect the species of animals living at each location?* (**Patterns; Constructing Explanations**)
- Use information in nature journals to write poems, stories, books, or research papers. (**ELA Standards: Text Types and Purposes; Production and Distribution of Writing; Research to Build and Present Knowledge**)

See *Extensions* for more suggestions.

See **NGSS Connections to Going Out: Field Activities** at the end of this chapter for more Disciplinary Core Ideas (DCI) connections.

Assessment:

- Have students share one of their observations with the class. Chart observations and look for patterns. *Why do such patterns occur?* (**Patterns**)
- Have students hand in journals; review them, but do not grade the content. This activity should encourage participation but not focus on right or wrong answers.

Extensions:

- *Bosque Field Journals* is intended as an introduction to the “River of Change” model activities in the *Guide*. Explore the model activities once students have discovered the bosque first hand. After repeated trips to the bosque, and as journal information increases, you may incorporate the *Who Grows Where?* and *Who Lives Where?* activity cards in your outings.
- Use field guides for plants, insects, reptiles, birds, tracks, etc., or *A Field Guide to the Plants and Animals of the Middle Rio Grande Bosque*, as informational texts during sustained silent reading time in the classroom. (**ELA Standards: Reading Informational Text**)
- The Bosque Search cards are great for building vocabulary, since they have pictures to help. (**ELA Standards: Vocabulary Acquisition and Use**)
- Older students might take a photo in the same spot each month (such as from their journaling spot, in the school yard or in a field location). Post these pictures in the classroom; observe, and reflect upon, changes over time.
- Older students can submit observations, including photos, to citizen science sites online, such as iNaturalist (plants, animals, fungi), eBird (birds), Budburst (plant phenology), Nature’s Notebook (plant and animal phenology).
- Construct an argument with evidence about a species that lives well in the bosque and why. Explain why another species from a different habitat would not survive well in the bosque. (**3.LS4.C; Engaging in Argument from Evidence**)
- Many families have multi-generational experiences with the bosque and river. See *River Stories* activity for an oral history activity.

NOTE: some discovery prompts include codes for NGSS Standards, but many are intended simply to encourage discovery and exploration and so are not linked directly to standards. These are some of the most effective prompts so we encourage their use!



Discovery Prompts



Bosque Search Cards – Paste copies of the Bosque Search Cards (included below) into journals before you head to the field for your first visit. Search Cards provide an excellent introductory prompt and may be referred to during subsequent visits as well.



Senses - Divide your journal page into 4 equal sections, with each section labeled with a sense to record: **hear, see, feel/touch, smell**. Non-readers may draw pictures (ear, eye, hand, nose). When in your journaling spot, sit quietly and observe your surroundings, recording what you hear, see, feel and smell.



Levels - *What do you see when you look up, look down, or look in between?* Divide journal page into three horizontal sections, label as **up, eye level, down**. Record what you see.



Find a friend - Find a natural, non-living object that can fit in your hand, such as a rock, leaf, piece of bark, feather - anything that catches your interest. Get to know it. *How does it feel? How does it smell? What colors do you see? Where did your friend come from? Is it part of something, such as a plant or animal? Can you find where it came from? How does it fit into the ecosystem?* Carry your friend with you for a while, but **be sure to return it to its bosque home before you leave**. Draw a picture of your friend, or use words to describe it.



I saw something special in the bosque (or school yard) today. – Pick something special that catches your eye. Spend some time observing your special discovery, then write or draw about it.



I notice... I wonder... It reminds me of... Make a chart with 3 columns. Write down something you notice. *What do you wonder about it? What does it remind you of?* Try to include more than one observation.



Study a stump. – Draw or use words to describe the stump. *Do you find any other organisms living there? How do you think the tree came down?*



How many shapes of leaves can you find? – Students may draw leaves or do leaf rubbings. Record the description, color, shape, how it looks, how it feels. Use field guides to identify (either in the field or back in the classroom). This can be extended to include native and non-native (exotic) categories by having students divide their pages into two sides, one for leaves from each category.



Pillbugs – *Where are they? How many can you find? How many legs do they have?* Draw and describe what you see.



Natural / Man-made – *Is there something that doesn't belong in the bosque?* Make a chart with 2 columns and record natural and man-made items.



Find a large tree with heart-shaped leaves. – This is a cottonwood. Students may draw or do leaf rubbings. *Why do trees have leaves?* Pretend you are a tree and reach your branches into the sky. *How does it feel to be a tree?* Dig your roots down deep and sway with the wind. *Could you stand strong against winter storms? Do you see any flowers in the tree? What do the different parts of the tree do?* Lie down under the tree to see branches against the sky. *How many students does it take to circle the tree, embracing the trunk?* Alternately, have each student be a different part of the tree; *what is the purpose of each part?* (1.LS1.A; 4.LS1.A; **Structure and Function**)



Focus on leaves. – Have students gather cottonwood leaves from the ground. Look at them closely. *Are they all the same?* Play the game where everyone gets one leaf; spend time paying close attention to your leaf. *Are there any individual markings or patterns in the leaf?* Put all leaves in a pile. Students sit in a circle while the teacher pulls out one leaf at a time and sends it around the circle. *Can each student find "their" leaf?* Discuss how seemingly identical leaves are actually different. *How are the students able to tell them apart?* In some cases, it is the variation in the inherited information as the leaf grew; in others it might be an insect that chewed it, or the tree received more or less water, thus affecting its growth. (1.LS3.B; 3.LS3.B)



Parents & young – Make a chart for data collection with 2 columns, one for adult and one for young. Record examples of parent and young plants and animals (big cottonwoods/seedlings, adult bird/nest or egg or fledgling, adult insect/young insect. (1.LS1.B; 1.LS3.A)



Look for baby cottonwoods. – Make a chart for data collection with 2 columns, one for baby and one for old cottonwoods. Count trees at a spot close to the river, and at another spot farther away. *Where do you see more young trees? How are the young trees similar or different from adults?* (1.LS3.A)



Ants – Look at the different kinds of ants in the bosque. *Can you find where they are?* Look on the ground, in trees, in bushes – anywhere! List some differences you see among the ants (shape, size, color, location). *How do ants use their antennae? Do you ever see just one ant? Why do ants live in groups?* (1.LS1.D; 3.LS2.D; 4.LS1.D)



Make a map of the area (school yard or bosque). (**Geography: Geographic Representations & Reasoning**)





What looks different in the bosque (or school yard) today? – This works best after several visits to the natural area.





Additional Data Collection Prompts for Older Students:


Older students can divide journal pages into charts to collect data for later analysis. This method may be used for many types of descriptive investigations, depending on your goal, and allow for analyses back in the classroom. Some suggestions include:


 **Vertebrates/Invertebrates** – make a chart with 2 columns labeled **Vertebrates, Invertebrates**.

 **Is that alive?** – Make a chart with 2 sections labeled: **Biotic, Abiotic**


 **Decomposition** – Make a chart with 2 columns labeled: **Signs of Decomposition and Decomposers**

 **What birds do we see in different areas?** – Make a chart with 4 columns labeled: **Habitat, Species observed, Number #, Comments**. *Why might you see different species in different places? What would happen if certain habitats were lost?* (2.LS4.D; 3.LS4.D)

 **Interdependent relationships** – Make a chart with 4 columns labeled: **Producers, Consumers, Decomposers, Nonliving**. (5.LS2.A)

 **Habitats** – Food, Water, Shelter, & Space. Make a chart with 4 sections labeled: **Food, Water, Shelter**. “Space” is hard to document so put **Animal Signs** in the fourth section (2.LS4.D; 3.LS4.D)




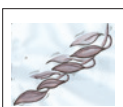







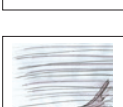
As a culminating activity, consider this prompt on a final trip to the bosque.

 **Compare today and the future.** Look at the area around you. *How do you think it will look in 20 years? Draw pictures to compare with now. How can you help the plants and the animals that live in the bosque? Challenge students to think about what they would do to help the bosque of the future. What would be the outcome of their efforts in 20 years?* Back in the classroom, allow for creative ways to show their ideas—build models, draw, video, etc. This prompt works best near the end of the school year, after students have taken multiple trips to their natural place and done some of the classroom activities from the *Guide*. You might also show students photos of the past. *How has the bosque changed already?* (K-2.ETS1.B; K.ESS3.C; 3-5. ETS1.B; 5.ESS3.C; Obtaining, Evaluating, & Communicating Information)

The Beaufort Wind Scale

The Beaufort Wind Scale is a system of recording wind velocity (speed) devised in 1806 by Francis Beaufort. It is a numerical scale ranging from 0 for calm to 12 for a hurricane. Sailors and forecasters use the Beaufort Wind Scale as a standardized way to rate wind speed.



Beaufort Scale	Wind Speed		Effects on Land	
	mph	kph		
0 (calm)	below 1	below 1		
1 (light air)	1–3	1–6	Smoke rises straight up; tree leaves still	
2 (light breeze)	4–7	7–12	Rising smoke drifts; wind felt on face	
3 (gentle breeze)	8–12	13–19	Leaves rustle; paper and dust raised	
4 (moderate breeze)	13–18	20–30	Small branches move; paper blows	
5 (fresh breeze)	19–24	31–39	Small trees sway, big branches move	
6 (strong breeze)	25–31	40–50	Big branches move; wind whistles	
7 (near gale)	32–38	51–62	Trees in motion; walking difficult	
8 (gale)	39–46	63–74	Twigs break; walking slow	
9 (strong gale)	47–54	75–87	Slight structural damage	
10 (storm)	55–63	88–102	Trees uprooted; structural damage	
11 (heavy storm)	64–72	103–117	Widespread damage	
12 (severe storm)	above 73	above 118	Severe damage and destruction	



Clouds

Identify the types of clouds you see today using the list below.
Draw the clouds you see in your journal.

High Level Clouds

Above 20,000 feet (6 km)

Cirrus (SEAR-us) feathery clouds, often a sign of approaching warm front.

Cirrocumulus (SEAR-oh-Q-mule-lus) puffy individual clouds closely scattered across the sky

Cumulonimbus (Q-mule-oh-NIM-bus) tall layered clouds that may produce thunderstorms with heavy rain, have anvil shaped tops and will extend to low levels as storms develop.

Mid-level Clouds

Between 6500 ft (~ 2km) and 20,000 feet (6 km)

Altostratus (ALL-toe-Q-mule-us) may be in lines; if seen in the morning, they may indicate storms later in the day.

Nimbostratus (NIM-bow-STRAT-us) produce steady rain or snow; it will lower with precipitation.

Low Level Clouds

Below 6500 ft (~ 2 km)

Cumulus (Q-mule-us) a vertically expanding cloud that may develop into a thunderstorm

Stratocumulus (STRAT-oh-Q-mule-us) layers of cloud clumps with thick and thin areas; appear either ahead or behind a frontal system.

Stratus (STRAT-us) flat clouds that may cover the sky with gray; may have light rain or no rain.

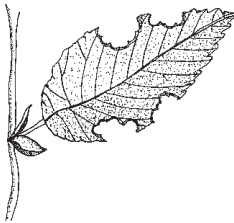
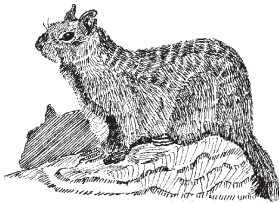

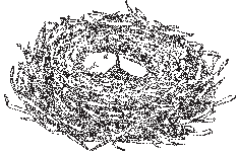


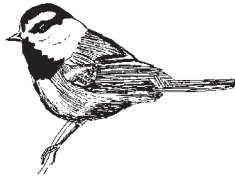
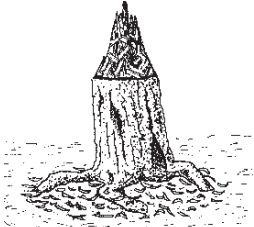


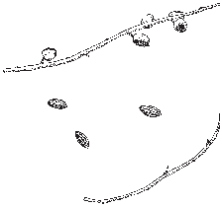







Bosque Search Cards

Drawings by Gregory Scheib and George Mauro



Year-round Bosque Search Card

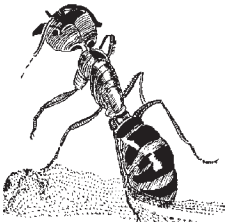




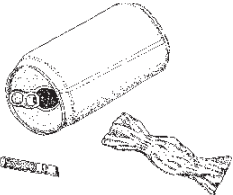
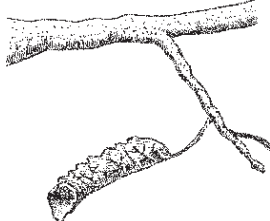



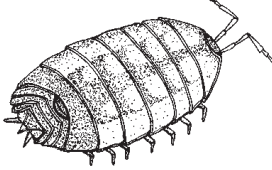
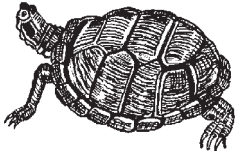

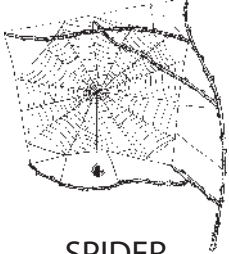
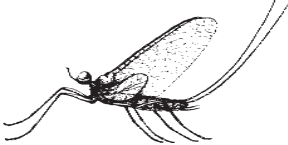
 <p>CHEWED LEAF</p>	 <p>SQUIRREL</p>	 <p>ANIMAL BURROW</p>	 <p>BIRD NEST</p>
 <p>COTTONWOOD STAR TWIGS</p>	 <p>ANIMAL TRACKS</p>	 <p>PERCHING BIRD</p>	 <p>BEAVER TREE</p>
 <p>SANDY SOIL</p>	 <p>COTTONWOOD LEAF</p>	 <p>RUSSIAN OLIVE SEEDS</p>	 <p>BARK BEETLE TRACKS</p>
 <p>SNAG</p>	 <p>ANIMAL PELLETS</p>	 <p>CICADA SHELLS</p>	 <p>CANADA GOOSE</p>



Bosque Search Cards

Drawings by Gregory Scheib and George Mauro


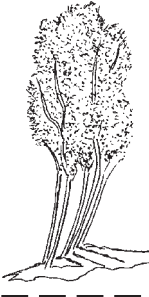


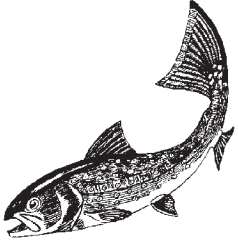
Seasonal Adaptations Card: Spring, Summer Fall

 <p>ANT</p>	 <p>GRASSHOPPER</p>	 <p>HUMMINGBIRD</p>	 <p>YELLOW LEAF</p>
 <p>SALT DEPOSIT</p>	 <p>TRASH</p>	 <p>ROLLED LEAF</p>	 <p>COTTON</p>
 <p>LIZARD</p>	 <p>DRAGONFLY</p>	 <p>PILLBUG</p>	<p>DRAW SOMETHING INTERESTING</p>
 <p>TURTLE</p>	 <p>FEATHER</p>	 <p>SPIDER</p>	 <p>AQUATIC INSECT</p>

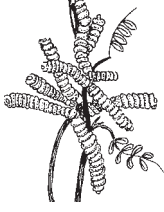
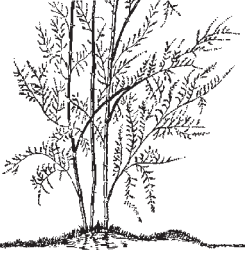
Special Adaptations Squares



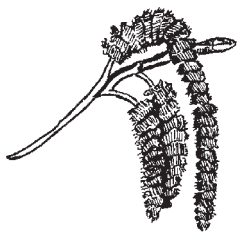
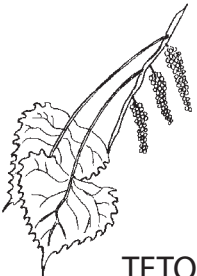

Upper River

 <p>ELK</p>	 <p>ALDER</p>	 <p>DIPPER</p>
 <p>BEAVER LODGE</p>	 <p>TROUT</p>	

Lower River

 <p>SCREWBEAN MESQUITE</p>	 <p>TAMARISK</p>
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Special Seasons

 <p>MALE CATKINS</p>	 <p>TETONES</p>	 <p>SANDHILL CRANE</p>
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2. Signs of Humans

Scavenger Hunt in the Bosque

Description: Students search for impacts of humans in the bosque or other natural area by walking a trail and using a scavenger hunt list to keep track of signs of humans.

Objectives: Students will:

- identify signs of humans in the bosque;
- understand the impact of human activity in the bosque;
- consider ways to decrease these impacts; and
- evaluate their own actions while in the bosque.

Materials:

- Student Activity Sheet:— Signs of Humans--Scavenger Hunt in the Bosque, one per student There are two versions of the activity sheet.
- Pencil
- Optional: field journal
- Thermometer
- Compass
- Beaufort Wind Scale & Cloud Chart [*Bosque Field Journals*]

Phenomena: Humans impact natural areas in both beneficial and harmful ways.

Lesson Questions:

- *What signs of humans can we see during our walk in the bosque?*
- *Which signs reflect beneficial impacts of humans or harmful impacts of humans on the bosque?*

2. Signs of Humans--Scavenger Hunt in the Bosque



Grades: 3–8

Time: material preparation: 10 minutes
class activity: one hour

Subjects: science, social studies

Terms: *acequia, detrimental, domestic, exotic, graffiti, impact, levees, naturalized, sign, vandalism*



New Mexico STEM Ready! / Next Generation Science Standards

NGSS DCIs and New Mexico State Performance Expectations


NOTE: see NGSS Connections to *Going Out: Field Activities* at the end of this chapter for more possible field trip NGSS connections and for suggestions using each standard.


5.LS1.C Organization for Matter & Energy Flow in Organisms*

5.ESS3.C Human Impacts on Earth Systems

MS.LS2.C Ecosystem Dynamics, Functioning & Resilience*

MS.LS4.D Biodiversity & Humans

MS.ESS3.C (MS-ESS3-3 NM) Human Impacts on Earth Systems * 

MS.ETS2.B (MS-ESS3-3 NM) Influence of Engineering, Technology, & Science on Society & the Natural World* 

NGSS CCCs

Cause & Effect; Systems & System Models*; Energy & Matter*

NGSS SEPs

Engaging in Argument from Evidence; Obtaining, Evaluating & Communicating Information*

*indicates extension activity

Background:

This activity challenges students to think and observe with a different perspective—to look for things that would not be there except for humans, or were not in the bosque in prehistoric times.

Since the time of indigenous people of North America and as the Spanish began to settle along the Rio Grande, people have made changes to the bosque. Humans trapped floodwater and dug acequias to divert river water to irrigate crops. They cut down trees and altered the course of the river. Introduced plants and animals, roads, levees and jetty jacks, irrigation systems, homes, farms and recreational activities have altered the natural flow of the river and disrupted native ecosystems.

The bosque today reflects the many activities of homesteaders, visitors, developers and agencies, which have altered the bosque plant and animal communities and the hydrological system. Every activity has effects, some of which we are just beginning to recognize. Some of these activities are beneficial, while many others produce long-term detrimental consequences.

Here are some human-induced changes you might find on a hike in the bosque:

Many **exotic plants** are here because of humans. Russian olive and saltcedar (tamarisk) trees were originally planted along riverbanks during reclamation projects. They were intended to serve as windbreaks and to hold soil in place when the river flooded. They have now become “naturalized,” meaning they reproduce and spread on their own. Others, including elm, mulberry, tree of heaven and pampas grass, were intentionally planted by people and now occur in the bosque. Mulberry and Russian olive fruits are relished by birds and other animals.



Russian olive leaves



Exotic animals have also been introduced. Starlings were brought to America in the 1800s and released into New York's Central Park and other locations in the U.S. Starlings are cavity nesters and will even oust woodpeckers that created a hole in order to use it. House Sparrow (English Sparrow) was introduced to New York City in 1852 or 1853 and by 1900 were one of the most abundant birds in North America. Since their introductions, both Starlings and House Sparrows have spread across the United States, including the Middle Rio Grande Valley.



European Starling
Sturnus vulgaris

Jetty jacks were placed in the riverbed and along the riverbank to slow the floodwater, straighten the river and protect the **levees**. Some of these jetty jacks are now buried in river sand or partially submerged in the river.



Feral dogs and cats have been abandoned in the bosque by people no longer wanting to keep them as pets. Also abandoned are **domestic** ducks, rabbits and exotic turtles like Red-eared Sliders. When the animals have lost their appeal, they are abandoned here.

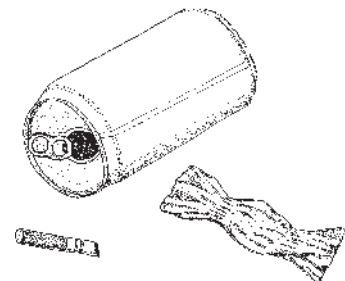
Sawn logs tell of a woodcutter, someone seeking firewood, building material for their home, or clearing trails.

Burned logs indicate a fire. Lightning causes a very small percentage of bosque fires. Smoking, weed burning, fireworks and arson are the most common causes of bosque fires.

Bird/bat houses have been installed to attract owls, woodpeckers, wrens, chickadees and some bats.

A **sneaker print** or **bike track** is a record of your visit to the bosque. The paved and gravel trails are part of Albuquerque's trail system.

Trash: The bosque has a long history of being used as a dumping ground. Tons of garbage have been removed from the bosque over the years, but some of this rubbish remains. Present-day trash shows little care





for our natural areas. Plastic bags blow away and land in trees, stuck seemingly forever. Birds incorporate trash into nests, sometimes with ill effects. Trash in the river itself includes floating items that animals may mistake for food.

Graffiti/Carvings: Writing or drawings scribbled on trees, rocks or other objects within natural areas detract from the beauty of the place. Graffiti is also illegal. Carvings in tree bark open the tree's protective covering, exposing the plant to disease and insects, often with detrimental effects.

Pollution impacts water quality of the river, affecting aquatic organisms as well as terrestrial systems when the river floods. Runoff from agriculture (fertilizers), industry (heavy metals, petroleum hydrocarbons) and mining (mine waste, heavy metals, acidic water) all negatively impact water systems. Motor oil washes from city streets into the storm drains that discharge into the river. Some people dump their used motor oil directly into city drains, causing a detrimental effect on the plants and animals of the river community.

Dog poop left behind adds unwanted contamination to the river, using up precious dissolved oxygen as it decays and increasing fecal coliform bacteria, which are dangerous to many living organisms.

Procedure:

For younger students this can be a culminating focus after several trips to the bosque.

Older students can find complex effects of human interference over the last century.

♣ When you are looking for animals in the wild, you are looking for animal “**sign**”—evidence that the animal has been there. In this activity, we are looking for human “**sign**”—evidence that humans have been there, and have made an impact on the area. Just like finding signs of wildlife in the bosque, students are to look for evidence of human activity in the bosque.

♣ Ask students, *How have humans altered the bosque in the past and in modern times?* Next ask, *How might your activities during a field trip in the bosque also cause changes?*

Dropping trash or trampling plants are two negative effects. Reseeding native grasses, clearing deadwood or installing nesting boxes would be beneficial ones.

♣ Distribute student activity sheet “*Signs of Humans--Scavenger Hunt in the Bosque.*” NOTE: the activity sheet may be added to student field journals.

♣ Have students mark the signs of human activity as they find them on their walk. Have students add other things they see that are not on the list.



- ◆ Discuss the impact of the human signs:
 - *Was this item helpful or harmful?*
 - *Was this intentional or unintentional? If intentional, what was the purpose?*
 - *What human activity caused this sign?*
 - *What might be done to mitigate any negative impacts?*
 - *What other signs of human influence can you find?*

How do the human-caused changes to bosque habitats affect the organisms living there?

Sometimes intentional changes made in the past were thought to be beneficial at the time, but now are considered harmful. *Do you see any examples of impacts that might have been made with good intentions, but that are now known to have negative effects?* (Jetty jacks are a good example.)

What value can people put on the bosque?

What benefit does the bosque give to humans? (Monetary, spiritual, ecological, mental, etc.?) (MS.LS4.D; Cause & Effect)

Assessment:

From your walk in the bosque, think about the signs of humans changing things in the bosque. There are great things and maybe not so great things. *Can you make some lists?* Here are some things your students might have observed.

- **Great:** paths to walk on, benches by the river, trees planted by people, ponds, wetlands and water channels created for wildlife, bird boxes, other restoration projects such as thinning exotic plants.
- **Not so great:** litter and trash, people careless with fires so parts of the bosque burned.
- **Not easy to see:** There is less water in the river. The old cottonwoods are dying and few new ones are growing. We are in a drought caused by climate change world-wide; because of drought and decreased flooding, there are more fires, and fewer new trees.

What are ways that humans are helping the river and the bosque?

What restoration projects did we see on our walk? Are any animals or plants helped by these restoration projects? If so, which animals or plants are helped, and in what ways are they helped through those projects?

Is it possible to make the bosque healthier while people are still living along it? Can it be restored to what it was like before humans? In what ways might or might not this be possible?



Think about things you did not see. *Are there buildings next to the river?* In some cities, municipal development reaches the riverbanks. In this way, Albuquerque has protected its bosque to some degree. *What other things are not seen along the bosque and river that might have detrimental effects?*

Have students write a claim, evidence, reasoning statement about a human impact on the bosque. **(5.ESS3.C; Engaging in Argument from Evidence)**

Extensions:

- Have students carry (and use) a litter bag on their walk.
- Have students plan and carry out a service-learning project (see Chapter 7).
- Back in the classroom, have students draw a human-impact bosque scene and a scene as it might be without human impact.
- Research one category of human sign found on the walk. *What is its impact?* For example, look up pet waste, calculate the quantity of pet waste in your community, and research the effects of pet waste that is not disposed of properly. (City of Albuquerque has a website for pet waste and stormwater quality.) **(Math standard)**
- On your walk, look for the diversity of living organisms. Try to get a sense of the biodiversity of the bosque. Make lists of plants and animals or animal sign observed. *Do you see the introduced species saltcedar? How do introduced species, such as saltcedar, affect native plants in the bosque?* **(MS.LS2.C)**
- Compare aerial photos of Albuquerque to those of other large cities with rivers. *Which cities have preserved native vegetation?*
- Plants need sunlight, air and water to survive—they make their own food with just these things. Animals need to eat other organisms to survive. They might eat plants, or they might eat other animals. Use Species of Greatest Conservation Need as examples. These are animals that are threatened or endangered, or considered at risk of becoming so, and so need extra management attention. *How does each species get the materials and energy it needs to survive?* **Rio Grande Silvery Minnows** eat algae and tiny plant pieces found in the river. **New Mexico Meadow Jumping Mice** live in marshes where they eat flowers and seeds of grasses and other plants, in addition to insects. **Northern Leopard Frogs** eat insects that fly near water; they must feed in wet habitats. **Southwestern Willow Flycatchers** also eat insects that fly near water and so live in riparian vegetation. **Bald Eagles** eat fish or carrion (dead animals), so they typically live and hunt near water courses. All of these animals need to live in or near wetland habitats so that they can acquire the materials and energy needed for body repair, growth and motion. **(5.LS1.C; Energy & Matter)**



- Focus on habitat changes affecting wildlife:

Why have wildlife species become rare, threatened or endangered (in New Mexico they are designated Species of Greatest Conservation Need-SGCN)? A main reason is habitat change. Within the bosque ecosystem, habitat changes have major impacts on the wildlife of the bosque. What habitats have been reduced in the last century? These changes are human-caused changes.

- As you do your walk in the bosque, look for different habitats. Note areas of wetland, dense vegetation, sapling tree thickets, etc.—the types of habitats that were reduced with the many changes to the Rio Grande. Also look for engineering projects that are replicating some of those lost habitats.

Below are some examples of habitat changes affecting animals listed as SGCN in New Mexico.

- Have students research one of the species listed to understand why their numbers have been reduced.
- Research how managers can improve habitat conditions in order to successfully manage species.

Rio Grande Silvery Minnow (*Hybognathus amarus*)—needs slow, muddy backwater areas, away from the main river current, for reproduction. These conditions were reduced when the river was confined to a narrow channel, overbank flooding was prevented and demands on the water increased. Fortunately, there are projects to create minnow habitat. One example is the Secondary Channel that was constructed west of the Rio Grande Nature Center. In high runoff years, water flows through the channel and into the floodplain to provide conditions for the Silvery Minnow to reproduce.

Northern Leopard Frog (*Lithobates pipiens*)—needs marshy ponds. Humans, in narrowing the river and reducing the volume of water, have reduced wetlands up and down the river corridor. By allowing domestic livestock to spend extended time near water, they disturb frog habitat. Other threats are chemical pollutants and pesticides that drain into the marshes, as well as introduced/exotic predators including fish and bullfrogs. Restored wetlands benefit this species.

Bald Eagle (*Haliaeetus leucocephalus*)—generally winters in New Mexico, where they prefer to fish in large water bodies such as rivers and lakes. Their decline in North America is due to pesticide use, because the poison becomes more concentrated in animal tissues as it moves up the food chain (bioaccumulates) from herbivores to carnivores, such as Bald Eagles, which are predators and scavengers. Maintaining water in streams, banning DDT and reducing the use of other pesticides have helped increase the population numbers of Bald Eagles, but vigilance is still needed.

Yellow-billed Cuckoo (*Coccyzus americanus*)—nests in riparian forests with dense understory vegetation. They have been found nesting in saltcedar thickets along the Pecos River. Cuckoos do well in restored areas where cottonwoods and willows have been replanted.




Southwestern Willow Flycatcher (*Empidonax traillii extimus*)—needs thickets of young riparian trees to build its nest. Since the river has been confined to a narrow channel, reproduction of riparian trees has decreased as overbank flooding was mostly eliminated. There are fewer patches of young cottonwoods and willows available for flycatcher nesting. Restoring degraded riparian ecosystems and protecting those that remain are essential to the flycatcher’s survival.

New Mexico Meadow Jumping Mouse (*Zapus luteus*)—needs moist, dense habitats supporting grasses, sedges, forbs, and willows, particularly along permanent waterways. The destruction of streamside vegetation by mowing and livestock grazing, lowering water levels, drought and wildfires has decreased this mouse’s habitat. Restoring these wetland habitats will benefit this mouse.

San Juan River species:

Colorado Pikeminnow (*Ptychocheilus lucius*)--needs long stretches of free-flowing, warm, muddy water for most of its life, but will move 125 miles (200 kilometers) upstream to cold water rapids to lay their eggs. Then the fry need shallow backwater to grow to 8 inches (20 cm) before moving into faster water. Today, there are dams obstructing the river, there are few backwater areas, and the river flow is reduced; there are also pollutants that affect the young fish. Protecting stream flow and backwater habitats will help pikeminnows.

Razorback Sucker (*Xyrauchen texanus*)—needs high spring flows to lay eggs, then the young fish need to find quiet backwater areas to survive and grow. Though the fish will lay eggs in river reservoirs, the fry do not survive because there is not enough suitable food and too many non-native fish predators. Protecting natural stream flow and backwater habitats will help razorback suckers as well.

(5.LS1.C; MS.ESS3.C (MS-ESS3-3 NM); MS.ETS2.B (MS-ESS3-3 NM); Cause & Effect; Systems & System Models; Engaging in Argument from Evidence; Obtaining, Evaluating & Communicating Information) 

Reference: bison-m.org New Mexico Department of Game & Fish, Biota Information System of New Mexico.



Signs of Humans--Scavenger Hunt in the Bosque

Name:

Date:

Temperature:

Mark wind direction

Describe amount of wind

Sometimes the only proof of animals in the bosque is the sign they leave which tells of their activities. A feather from a preening bird falls to the ground; scratches in the soil mark the hole of a hiding mouse. Perhaps scat on the trail tells the story of a night's hunt. Tracks in mud record the passage of those who came to drink. Humans also leave signs of their activities. As you walk the trail look for signs of human activity.

Human signs: Mark those you see.

- Russian olive
- elm
- mulberry
- saltcedar
- man-made wetlands/marsh
- acequia
- trash
- carving in tree
- jetty jacks
- sawn log
- burned log
- bird house
- trail
- trash in river
- starling
- dog poop
- household pets
- graffiti
- sneaker print
- bike track

Signs of Humans--Scavenger Hunt in the Bosque



Name:

Date:

Temperature:

Mark wind direction

Describe amount of wind

Sometimes the only proof of animals in the bosque is the sign they leave which tells of their activities. A feather from a preening bird falls to the ground; scratches in the soil mark the hole of a hiding mouse. Perhaps scat on the trail tells the story of a night's hunt. Tracks in mud record the passage of those who came to drink. Humans also leave signs of their activities. As you walk the trail look for signs of human activity.

	Item	Helpful / Harmful	Intentional / Unintentional	What human activity caused this?
	Russian olive			
	elm			
	mulberry			
	saltcedar			
	man-made wetlands/marsh			
	acequia			
	trash			
	carving in tree			
	jetty jacks			
	sawn log			
	burned log			
	bird house			
	trail			
	trash in river			
	starling			
	dog poop			
	household pets			
	graffiti			
	sneaker print			
	bike track			



3. *Naturalist Notebooks*

Description: Students learn how to keep notes on their observations and activities in the bosque, and to collect different types of data.

Objective: Students will further develop essential observation and recording skills required of naturalists, scientists, or other nature appreciators.

Materials:

- Naturalist Notebook activity pages
- Pencils
- Nature journal, or hard surface for writing, such as cardboard, notebook, or a clipboard
- Thermometer
- Compass
- Tape measure
- Stop watches or phones with stopwatches (4)
- Field guides for reference back in the classroom

Phenomena: The speed of the river varies; some cottonwood trees are huge and others small; different birds live along the water compared to in the trees.

Lesson Questions:

- *How can I measure the speed of the river? How do I measure cottonwoods? Which birds live near water? In the trees?*

3. *Naturalist Notebooks*



Grades: 5–12

Time: 30 minutes to one hour

Subjects: science, language arts, mathematics, visual arts

Terms: *circumference, cohort, contour map, diameter at breast height (DBH), keystone species, shape map, speed*



New Mexico STEM Ready! / Next Generation Science Standards

NGSS DCIs

Note: Possible DCI connections will vary. See **NGSS Connections to *Going Out: Field Activities*** at the end of this chapter for more possible field trip NGSS connections and for suggestions using each standard.

NGSS CCCs

Patterns

NGSS SEPs

Planning & Carrying Out Investigations; Analyzing & Interpreting Data; Using Mathematics & Computational Thinking

Common Core Connections

Mathematics

Measurement & Data

5.M.D Represent/Interpret Data

Statistics and Probability

Background:

This activity builds on skills developed using *Bosque Field Journals* and provides prompts for more extensive observations and simple data collection. Notebooks are included for three topics: the Rio Grande, the Rio Grande Cottonwood and Birds of the Bosque. All three notebooks follow the same format—introduction, site description and general observations, directed observation and data collection, and synthesis. Data collection includes verbal descriptions, one or more field sketches, and recording quantitative data. Students are encouraged to reflect on what they have observed and to ask questions for further inquiry. Back in the classroom, students perform simple data analyses, graph their results, and are encouraged to continue their learning using field guides and other resources. The notebooks are designed with four pages focused on a single topic, which may be used in their entirety for older students, or sections may be used individually for younger students. They may be glued into students' nature journals. An additional *Naturalist Notebook: Fire*, is located in Chapter 6

Procedure

📌 Copy notebook pages as needed.

📌 Data Collection (**Planning & Carrying Out Investigations; Measurement & Data**):

- The **Rio Grande** notebook focuses on the river, with data collected for measuring rates of river flow (speed). This can also be done in a ditch if the river is not accessible.

Each team will need five sticks, each of similar size and big enough to be seen from shore. Find a location along the bank where you can measure out 20 feet, and put markers (or students) at 0, 5, 10, 15 and 20 feet (this can also be measured in meters, or in steps if they are consistent). Run five replications. An upstream team member tosses the stick into the river. Toss it a bit further upstream than the starting point, then the student at 0 feet yells "Start" when it passes the marked spot; a downstream team member begins timing and stops when it passes 5 feet. Repeat and record



the time to pass 10 feet, repeat for 15 feet and for 20 feet. Then do one additional run, recording the time the same stick passes each distance (at 5, 10, 15 and 20 feet). Back in the classroom, you will talk about how to determine the speed of the river, and how sample distance can affect your measurement.

- The **Rio Grande Cottonwood** notebook includes the determination of “**diameter at breast height**” (or “**DBH**”), a standard measurement used by forest ecologists and others to compare tree sizes. The circumference of a tree is measured using a soft measuring tape at 4.5 feet (1.35 meters) above ground, and the diameter is calculated. Make sure the tape is level and not kinked. Students will measure DBH of trees at two distances from the river and compare.
- The **Birds of the Bosque** notebook compares birds observed in two different habitats. Accurate species identification is not important, but students are encouraged to describe the birds they see, and to count the number of individuals of each species in each habitat. Species can be given a brief description *in lieu* of an identification (e.g., “large, all black” or “smaller than robin, yellow breast.”)

Simple bird identification tips:

- Notice the relative size of the bird. *Is it bigger or smaller than a robin? Bigger or smaller than a sparrow?*
- Notice the color. *What is the dominant color? Is it all one color, or several? Do you see any patches of color, such as on the wings or tail, under the chin, on its head?*
- Notice the bill shape. Bill shape tells you much about the bird! *Is it long and thin, short and stubby, dagger-like or fine, wide or narrow?*



Back in the Classroom (Patterns; Analyzing & Interpreting Data; Using Mathematics & Computational Thinking; Measurement & Data; Statistics & Probability; Represent/Interpret Data)

- **Rio Grande:** Students will graph the data collected to create a distance vs time graph, with distance on the y-axis and time on the x-axis. The slope of the graph (rise over run, distance over time) equals **speed** (in feet per second, or other units as appropriate). Graph each of the four distances that were timed separately, and graph the four points that were timed for the single run with a different color or symbol. Here are some points that may be discussed:
 - *The slope of a distance vs time graph represents speed. What is the speed of the river?*
 - The steeper the slope, the greater the speed.
 - *Is the speed (slope) constant among the five samples? Does sampling distance affect the measurement? Does measuring with one stick make a difference in the times?*



- *Do you expect the speed to be constant across the full width of the river? Why or why not? What factors might influence the speed of the river?*
- *If you are able to revisit the site at a later date, repeat the data collection. Does the speed change? What might be influencing the speed of the river at this time?*
- **Rio Grande Cottonwood:** Students will calculate DBH using the equation defining the **circumference** of a circle, $C = \pi \times d$, or to solve for diameter, $d = C \div \pi$ where C = circumference, d = diameter and $\pi = 3.14$. Calculate diameter for each of the 14 trees measured.

Example: If measured circumference is 150 cm
then diameter is: $150 \text{ cm} \div 3.14 = 47.8 \text{ cm}$

Graph the data using box & whisker plots, with one plot for the 7 trees at each of the two locations. This allows students to see the variation of DBH measurements within each location and between the two locations. Here are some points that may be discussed:

- *Are all of the trees within each location the same size? Do you think they are all the same age?*
- *What factors might affect the growth of the trees?*
- *Are the trees at the two locations similar in size, or different? Again, why do you think they are or are not?*
- *Did you have any problems measuring the circumference of the trees? If so, how did you address the problem?*
- **Birds of the Bosque:** To compare the bird populations between the two habitats, students should total the number of species and the number of individuals in each habitat. Create bar graphs for the number of species and total number of individuals in the two habitats. Species identification is not important, but students can use field guides to try to identify the birds seen. Some points that may be discussed:
 - *Which habitat had more species? More individuals?*
 - *Were the same bird species seen in both habitats? Why might you see similarities or differences in the species present?*
 - *How might the time of day affect your sampling? The length of your sampling period? Learn more about how ornithologists conduct bird surveys!*



Extensions

- See *Bosque Nature Journals* activity for possible DCI connections.
- For older students, we have included “Guidelines for Keeping a Field Journal” to provide more advanced options for keeping field journals in a class setting and beyond.
- **Measuring cottonwood tree height.** There are several methods to measure height; this is the 45° triangle method. *Materials:* a measuring tape, piece of square paper or cardstock, folded diagonally to create a right isosceles triangle, notepad and pencil. Hold the paper up to your eye and look along the longest side of the triangle toward the tree. You will need to find a spot where you can see the top of the tree at the top of the angle of the paper; walk closer or farther until you are in that spot. The two shorter sides of the triangle will be parallel to the ground and the trunk. Measure the distance from the tree trunk to where you stand and add the distance from the ground to your eye to get the height of the tree. Compare different trees and different areas of bosque. *Does tree height correlate with diameter?*



If you were to visit this same area in three months, do you think it will have changed? In what way? Why?

Empty rounded rectangular box for student response.

Who uses this water? List all possible users, including both human and non-human.

Empty rounded rectangular box for student response.

What are some questions you have about the river? What else would you like to know about it? Write your questions here:

Empty rounded rectangular box for student response.



The Rio Grande

The Rio Grande flows 1,885 miles (3,016 km) from southern Colorado to the Gulf of Mexico, through three states in the U.S. and four states in Mexico. It sustains many plants and animals and is used by people for agriculture, hydropower, manufacturing, recreational, and domestic uses. Today you will make some observations about the river as it appears in your area.

Name:

Date:

Time:

Location:

Temp:

Sky:

Wind Direction & Description:

Find a comfortable spot and spend at least five minutes observing the river.

Use words to record your observations.

I see

I hear

I smell

I feel

Large rounded rectangular box for student observations and notes.



How high do you think the river needs to rise to flood over the banks? How high to flood where you are sitting?

Calculate the speed of the river. You will need 5 sticks of similar size.

Measure 20 feet along the river, marking the distance at 0, 5, 10, 15 and 20 feet. Toss in a stick above the upstream end, yell "start" when it passes 0 feet; start timing and record the time it takes to reach 5 feet. Repeat to record the time to travel 10 feet, 15 feet and 20 feet. Then repeat one more time and record the time one stick travels 5, 10, 15 and 20 feet. You will calculate the speed back in the classroom.

- o Draw a shape map of the landscape in the box above.
- o Begin by drawing a line to represent the top of the trees, or mountains, or whatever meets the sky.
- o Next, drop down to the bank on the other side of the river and sketch in where the water meets the land.
- o Now sketch in the near bank on your side of the river.
- o Using simple images, draw in the trees, seedlings, and sand bars or whatever you see in front of you.
- o Label what you draw.
- o If the river is not bank-full, take a walk along the river bed to see the exposed gravel, sand bars, clay and/or silt (collectively called sediment).
- o Add these features to your landscape drawing.
- o Make sure you also indicate the direction the river is flowing.

Measure these with four different sticks:

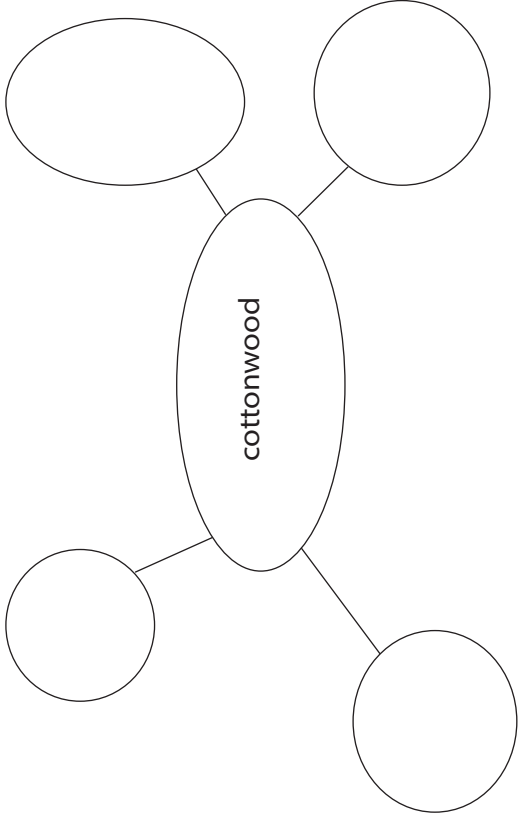
Distance (units =)	Time (seconds)
5	
10	
15	
20	

Measure these all with one stick:

Distance (units =)	Time (seconds)
5	
10	
15	
20	



As a keystone species, the Rio Grande cottonwood is connected to many elements of the bosque. Using the web below as a starting point, fill in the elements that are connected. You may add more elements or connections.



What are some questions you have about this tree? Anything you might want to know more about? Write your questions here:

Rio Grande Cottonwood

The Rio Grande cottonwood is a keystone species in the bosque. The word "keystone" literally refers to the piece of a stone arch that locks the other pieces in place. Without a keystone, the arch would collapse. Without the cottonwoods, the bosque would cease to exist as we know it. Many animals use it for shelter or food. The health of the cottonwood forest is also a good indicator of the overall health of the bosque. Today you will take a close-up look at a cottonwood.



Name:

Date:

Time:

Location:

Temp:

Sky:

Wind Direction & Description:

Find a cottonwood in the bosque. You will recognize it by its large size and triangular-shaped quaking leaves. Look at it very carefully for at least a few minutes. Use words to record some observations about the tree.

What does it look like?

What does it feel like?

What does it sound like?

Does it remind you of anything?

What other organisms do you see on or near the tree?



Make a simple drawing of the whole tree. Focus on the outline. What is the shape of the tree? Where do the branches begin? Do all of the branches have leaves?



A cohort is a group of trees that are all the same age—they germinate during the same event—but they may not be the same size. Some trees may grow bigger because they have more space, get more nutrients, or have a genetic tendency to grow faster.

Scientists compare tree sizes using a measurement called “Diameter at Breast Height” or “DBH”. This is determined by measuring the circumference of a tree at 4.5 feet (1.4 meters) above ground, and then calculating the diameter. You will measure the circumference of 7 trees at two locations, one closer and one farther to the river, and then calculate the diameter back in the classroom. Do you think trees within one location belong to one cohort? What about the trees at the two locations?

Location 1

Tree	Circumference (cm or inches)	DBH (cm or inches)
1		
2		
3		
4		
5		
6		
7		

Location 2

Tree	Circumference (cm or inches)	DBH (cm or inches)
1		
2		
3		
4		
5		
6		
7		

Pick one part (branch, leaf or anything that looks interesting). Examine it closely and draw it here:



Based on your observations, why are the birds here?
Give three possible reasons.

What was similar or different in the birds found in the two habitats?
What about the habitats was different, and how might that affect the birds present?

Now that you have observed the birds and their behavior, what else do you want to know? Write your questions here:

Birds of the Bosque

There are many different species of birds that live in the bosque. Some of the species are year-round residents; others spend only the summer or winter here. Still others only pass through as they migrate in the spring and fall. The goals today are to find as many species of birds as you can and to discover what they are doing and why they might be here. Remember, some of the birds are very secretive. You have the best chance of seeing birds if you are quiet.



Name:

Date:

Time:

Location:

Temp:

Sky:

Wind Direction & Description:

Scientists often look for bird evidence as much as for birds themselves. Write or draw the evidence of birds you find:

food

nests

feather

droppings

tracks

calls

holes

Where do you hear the birds in relation to you? Put marks in the box below to represent the birds. (You might want to use different marks to represent whether the birds are up high or at your level.)

YOU



We are going to examine some of the different habitats in the bosque. Ornithologists (scientists who study birds) spend many hours sitting quietly, watching and listening to birds. Go to each area and sit quietly for at least five minutes. Look and listen not just for the birds themselves but also for evidence of the birds.



Draw in detail one bird that you see in the area.

Along Water

In the Trees

Draw in detail one bird that you see in the area.

Describe what the bird is doing.

Describe what the bird is doing.

Record the number of birds you see in each habitat. Record the name, if you know it, or describe the bird briefly so you can distinguish between species.

Along Water - Bird Species or Description	# individuals
1 _____	_____
2 _____	_____
3 _____	_____
4 _____	_____
5 _____	_____
6 _____	_____

In the trees - Bird Species or Description	# individuals
1 _____	_____
2 _____	_____
3 _____	_____
4 _____	_____
5 _____	_____
6 _____	_____

Field Journal Guidelines



Naturalists keep field journals to record their observations and track their thinking about experiences in the outdoors. There are many ways to keep a field journal; methods vary depending on one's purposes. Here is one set of guidelines for keeping field notes in a "class" environment where notes will be turned in for grading and review.

Your assignment is to keep a field journal throughout our project. You are expected to maintain the index and to take notes in the field, during labs, on pertinent conversations, in class, and any other time you are working with things related to your field experience. The notes may be important to yourself or others many years down the line. You are expected to write your notes in the field or during the actual lab. Although you should try to be neat, field notes should not be perfect but rather reflect the conditions under which they were written.

Maintaining the Index

To help find information quickly in the future, it is important to dedicate the first few pages of your journal to indexing. (You may want to save the first page for a title page.) Make sure the journal has page numbers; if not, number the pages in the upper outside corner of each page. Each time you participate in an activity related to your study, make an entry in the index, which includes:

- page number(s) where you write your comments (drawings, etc.)
- your name or initials
- the date
- location (if applicable)
- a short description of what you were doing

Example: Page 32 mmm 12/18/22 RGNC BEMP Site, Albuquerque, NM, BEMP monthly collection

Taking Field Notes

Every time you go to the field, write notes. These notes should include:

- the date and day of the week
- your name and the names of your companions
- a brief description of the weather including the temperature (if you have no thermometer, use words like "chilly," "mild" or "hot"), cloud cover, any precipitation (rain, snow, hail, etc.), amount of wind
- a brief description of the location including the name of where you are and, if reasonable, travel directions so someone can find the site again
- notes about observations you have made (wildlife sighted, changes to the site, phenology of plants—such as cottonwood leaves are turning yellow on 25% of trees—etc.)
- notes about your work; explain what you are doing and why



You may also want to include:

- a sketch of something you have observed that you found interesting
- at least one question that you have thought of relating to your work in the bosque or relating to your understanding of the program
- natural history samples such as flat things like plant leaves or seeds which you tape into your notebook to aid with identification
- a map of where you are and what you are seeing

Taking Lab Notes

When you are no longer in the field, but working with materials collected in the field, such as water samples, or other kinds of data, this is considered lab work. Write notes while doing lab work to help:

- record pertinent data
- keep track of questions you have that you need to find answers to
- document any unusual observations
- record what day you are doing the work, what work you are doing, and who is working with you.
- include printouts of tables and graphs you generate from your data

Other Things to Include

Remember that other people will examine your field journal. Naturalists' field journals can be considered legal documents and have occasionally been used in legal cases. We hope this inspires you to do a good job of keeping notes, but remember we are all human and nobody keeps perfect field notes. Do the best job you can when you are in the field or the lab, and do not wait to make your notebook entries as a homework assignment to catch up on later—do them in the field or the lab.

Remember, your field journal is a written record. It documents the effort you put into a course of study and observation. From a legal perspective: if it is not recorded, it wasn't done. From a practical perspective: if you don't record something, you may forget about it later.

Be Sure to Include

- field notes with data
- lab notes to document samples worked on, dates, problems, data
- pertinent information from phone calls or conversations related to your field work
- drawings and diagrams to help illustrate your observations

Do NOT Include

- unprofessional remarks about other people
- inappropriate information
- class notes

Optional

- thoughts and personal insights on readings, class discussions, conversations with others
- notes on related lectures and programs
- newspaper clippings and other information that relates to your field work
- natural history notes, plant pieces, drawings, etc.

4. *Wildlife Detectives*



Description: Students look for signs of wildlife living in the area.

- Objectives:** Students will:
- find out what wildlife is living in the bosque or other natural area;
 - examine habitat needs of different wildlife species; and
 - use observation skills.

Materials: Field journals / paper and pencils, pens
Student handout pages (below); natural history guides (tracks, scat), see *Appendix B: Annotated References*

Phenomenon: Many animals live in the bosque (or other natural area), but I don't see them very often.

- Lesson Questions:**
- *What signs of animals can I find, and what do they tell me about the animals that made them?*

<p>4. <i>Wildlife Detectives</i></p> <p>Grades: 3–8</p> <p>Time: 30 to 60 minutes, depending on student interest levels</p> <p>Subject: science</p> <p>Terms: <i>habitat, invertebrate, scat, tracks, vertebrate</i></p>	
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**New Mexico STEM Ready! / Next Generation Science Standards**

NOTE: see NGSS Connections to *Going Out: Field Activities* at the end of this chapter for more possible field trip NGSS connections and for suggestions using each standard.

3.LS4.C Adaptation

3.LS4.D Biodiversity & Humans

Background:

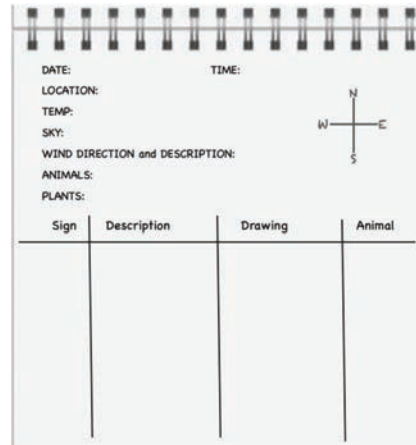
Numerous animals live in the bosque, but they are not always easy to find. **Vertebrate** animals (those with backbones) tend to stay in cool places during the heat of the day. They also may hear or smell humans and hide away from them. While most birds are active during the day (owls in the bosque being an exception), they are often more visible in the early morning and late evening. Fortunately, animals leave behind many signs that tell us they are in the area. These include **tracks, scat** (poop), bird nests, holes in the ground, mounds of dirt, feathers, fur, bones, scratches, bite marks, and more. Signs left by **invertebrates** (animals without backbones, including insects, spiders, isopods, etc.), include spider webs, cicada shells, rolled leaves, old cocoons, holes in the ground or bored into logs, and chewed leaves. Remember, invertebrates are wildlife, too!

These signs can tell us not only what animals live there, but also a great deal about the habitat needs of the animal that left them behind. **Habitat** includes the food, water, shelter and space suitable to an animal's needs; an appropriate arrangement of all of these is required for a given species to live in a certain location. By looking at where animals leave tracks, what they leave behind in scat, where they locate their nests, and so on, we are able to learn about their habitat requirements. In this activity, we search for signs of animals.

Procedure:

- ♣ It may help to scout out the area for this activity before your field trip. Some bosque trails now have gravel, which is not conducive to finding tracks. Find a location that has dirt trails, many trees and other vegetation as well as open areas. You might find an area with gopher mounds, bird nests or other obvious signs.
- ♣ Start by asking students what animals live in the bosque. Remember to accept invertebrates in their answers, as they are animals, too! *Ask if any students have been in the bosque before, and if so, what types of animals did they actually see?* There might be fewer animals listed now. Tell them that animals are often very hard to find, so today you will look for signs of animals, things that tell us that an animal is nearby. For older students, you may want to include the terms **vertebrates** and **invertebrates**.

- ♣ Divide the class into small groups. Assign each group a search area with clear boundaries. It can be “stay between this path and the river” or “within ten paces of this path” or whatever is appropriate. Many areas in the bosque look alike and if separated from the group, students can get disoriented and feel lost.
- ♣ Students should look carefully throughout the area for signs of animals. Look first; never put your hands, feet, or face where you have not looked. Things to look for include tracks, scat (poop), bird nests, holes in the ground, mounds of dirt (left by gophers), feathers, fur, bones, scratches, bite marks, spider webs, cicada shells or old cocoons, chewed leaves or sounds made by the animals.
- ♣ Record observations in field journals. Have students create a data chart in their journals with four columns:



Sign	Description	Drawing	Animal

- **Sign:** Record the sign observed (e.g., “nest,” “tracks,” “scratch marks”)
- **Description:** Provide details about the sign, including the environment in which the sign was found (e.g., “in a cottonwood tree,” “in sandy soil under a willow”). Include a tally when appropriate (e.g., number of small bird tracks, coyote tracks, etc.).
- **Drawing:** Draw the sign and include labels as appropriate and measurements, when possible.
- **Animal:** If possible, identify the animal that created the sign.

NOTE: Do not collect the evidence!

- ♣ If time permits, have students use natural history guides, or the guide included below, to identify their finds, if possible. If there is not time while in the field, try to identify signs when back in the classroom.
- ♣ At the end of the allotted time, bring students together to share findings. Use the following questions to lead a discussion of their discoveries.

How many different types of animals did you detect?

How many of each animal might live here? How do we know?

How many of these animals live underground? In the trees? On the ground?

Introduce the concept of habitat (the arrangement of food, water, shelter or cover and space suitable to animals’ needs). *What can we learn about an animal’s habitat needs by the signs they leave behind?*

How might each of these animals find food?



Where might each of these animals find water?

What types of homes did you find? Does that tell us anything about where the animal lives?

What would happen to these animals if these areas changed – there were no longer large trees, or the river dried up, or the plants died, etc.?

Can you name any animals that likely wouldn't be able to survive in this habitat based on their needs?

3.LS4.C, 3.LS4.D

Assessment:

Have students write about their findings, either in their field journal or as an assignment. Students should answer appropriate discussion questions as well.

Extension:

- For each sign that was found, draw or find a picture of the animal to match with a picture of its sign.
- Pick one of the animals discovered in the bosque. Research specific habitat needs for this species. Create a poster, model, etc. to share this information with the class.
- Additional activities in this *Guide* that would be appropriate follow-ups are “*The Web*” and “*Who Lives Where?*”
- Older students could discuss or learn more about what you can learn from tracks (size of animal, direction they were going, interaction with other animals), scat (diet, illness), etc.

Reference:

Track and Scat guides provided by the **Albuquerque Bernalillo County Water Utility Authority** Education Program. <https://www.abcwua.org/education/>

Animal Scat

Pellets, piles, splats & cylinders...

Pellets

Round - small
Rabbit



Round - tiny
Worm



Oval - small
Gopher
Squirrel
Mouse



Oval - medium
Porcupine



Redondo - pequeño
Conejo

Redondo - minísculo
Lombiz

Óvalo - pequeño
Tuza
Ardilla
Ratón

Óvalo - mediano
Puercoespín

Bolitas

Excrementos de animales

Bolitas, pilas, salpicaduras & cilindros...

Cylinders

Blunt, Medium
Seeds
Raccoon



Blunt, Medium
Broken
House cat



Blunt, Short
Bug parts
Skunk



Redondado, largo
Semillas
Mapache

Redondado, mediano
Descontinuado
Gato domestico

Redondado, corto
Partes de bichos
Zorillo/mofeta

Piles or Splats

Loose pile
with seeds
Coyote, sometimes



Large white splat
may have dark splotches in it
Crow
Owl
Hawk



Small white splat
may have dark splotches in it
Robin
Dove or pigeon
Other small bird



Pila suelta
con semillas
Coyote, a veces

Salpicadura blanco y grande
con morado o verde
Cuervo
Buho
Gavián

Salpicadura blanco y grande
con morado o verde
Mirlo
Paloma
Otra ave pequeña

Pilas o Salpicaduras

Pointy, large

Pet dog, coyote, fox

Pet scat is all one texture;
Coyote/fox scat contains

fur, bones, fruit, seeds, grass



Pointy, twisty
Weasel

Twisty with fur, bones

Large, green: Goose, crane

All one texture



Apuntado, grande

Perro doméstico, coyote, zorro

De perros es todo una misma
textura; de coyotes/zorros
contiene pelo, huesos, fruta,
semillas o sacate

Apuntado, sinuoso
Comadreja

Retorcido con pelo
y huesos

Apuntado, termino blanco
Minisculo: Lagartijo,




Grande, verde: Ganso, grulla
Todo una misma textura

Caution: do not touch animal scat, use a tool to investigate





Precaución: no toque los excrementos de animales, use un implemento para investigar

Animal Tracks

How many toes? ¿Cuántos dedos?

0 or 1 or 2	Long and narrow Human wearing shoes 	Short and round Horse 	Small with 2 toes Deer (unlikely in the bosque) 
	Largo y angosto Humano llevando zapatos	Corto y redondo Caballo	Pequeño con 2 dedos Cervo (poco probable en el bosque)




3	Webbed Duck Goose 	Partly webbed Coot 	Not webbed Most birds 	Not webbed Sandhill Crane 
	Palmeado Pato Ganso	Parcialmente palmeado Gallareta	No palmeado Casi todos los aves	No palmeado Grulla Gris





4	X-shaped Roadrunner Woodpecker 	Nails (Canine) Pet dog Coyote, Fox 	No nails (Feline) Pet cat 	No nails (rabbit) Cottontail rabbit (One foot Trail) 
	Forma de X Correcaminos Carpintero	Uñas (canino) Perro (mascota) Coyote, Zorro	No uñas (felino) Gato (mascota)	(Un pie Rastro) No uñas (conejo) Conejo del desierto





Huellas de animales

These drawings are not to scale!

¡Estos dibujos no guardan las proporciones!

4 or 5	5 hind toes and 4 front toes Sets of 2 tracks Porcupine 	Sets of 4 tracks Squirrel 	Sets of 4 tracks Mouse 
	4 dedos en las patas frontes y 5 en las traseras Grupos de 2 huellas Puercoespin	Grupos de 4 huellas Ardilla	Grupos de 4 huellas Ratón

5	Raccoon 	Weasel 	Beaver 	Barefoot human 
	Mapache	Comadreja	Castor	Humano descalzo

Other tracks and trails	
Turtle/tortuga 	Snake/serpiente 
Bicycle tire/llanta de bicicleta 	Beetle/escarabajo 



Description: Students look for insects, spiders, and other arthropods. The survey leads into an examination of microhabitats.

Objectives: Students will:

- discover which insects, spiders, and other arthropods live in the bosque (or other natural area);
- learn the differences between insects, spiders, and other arthropods;
- Learn about different microhabitats within the bosque (or other natural area) and how these locations are used by arthropods.

Materials:

- Bug boxes—one for every three students; small box with magnifier top is best, but any small clear vial or jar with a cover and a magnifying lens will work.
- Magnifying lenses (ideally one for every 1-2 students, if not incorporated into the lids of bug boxes)
- Insect nets (optional)
- Extra small jars
- Field journals / paper and pencils, pens
- Insect guides—one for instructor; student pages (Surface-active Arthropods) and /or Appendix E: Arthropods

Phenomenon: There are many arthropods in the bosque, and they can be found in a variety of different places (in trees, on the ground under leaf litter, in rotting logs, etc.)

Lesson Questions:

- *What arthropods can I find in the bosque (or other natural area)?*
- *What different types of microhabitats support arthropods?*

5. Crawly Creatures



Grades: K–8

Time: approximately 45 minutes

Subject: science

Terms: *arthropod, centipede, habitat, insect, invertebrate, isopod, millipede, microhabitat, spider*


New Mexico STEM Ready! / Next Generation Science Standards

(NOTE: see **NGSS Connections** in *Going Out: Field Activities* at the end of this chapter for more possible field trip NGSS connections and for suggestions using each standard).

3.LS2.C Ecosystem Dynamics, Functioning, & Resilience

3.LS4.C Adaptation

3.LS4.D Biodiversity & Humans

4.LS1.A Structure & Function*

MS.LS2.C Ecosystem Dynamics, Functioning, & Resilience

NGSS CCCs

Structure & Function

*indicates extension activity

Background:

Crawly creatures abound in the bosque! Although larger animals, including mammals and even birds, can be difficult to spot, **invertebrates** (animals without backbones) are numerous and relatively easy to find. **Arthropods**, invertebrate animals with jointed legs, are particularly easy to observe. These include **insects**, **spiders**, crustaceans (**isopods**), **centipedes** and **millipedes**. Because they are very accessible, students get excited to search for arthropods. A beetle may walk past you on the trail, a butterfly sail by on wings, a spider dart across a web to snag a fly, or a cicada buzz noisily from a branch. There is much to be discovered!

See *Appendix E* and *Bosque Bugs Boogie* activity for more detail on arthropod classification, identification, and natural history.

All animals require appropriate habitat to survive. **Habitat** includes the food, water, shelter and space suitable to an animal's needs; an appropriate arrangement of all of these is required for a given species to live in a certain location. Within a given habitat, such as the bosque, there are smaller, more specialized areas referred to as microhabitats. A **microhabitat** is a small area that is different from the surrounding habitat. For example, within the bosque or riparian habitat, microhabitats could include a grassy area, underneath a rock, inside a rotting log, on the branch of a large tree, etc. Microhabitats provide even more specialized conditions for the animals that live there. Whether an area is considered a microhabitat to a given species depends on the size of that animal; a millipede might live completely within a rotting log, but a coyote in the same area might consider the log to be just one small part of its home range. In this activity, students will search different microhabitats within the bosque to discover their inhabitants.

Procedures:

- Ask students what animals they have seen in the bosque. If you have done *Wildlife Detectives*, your students may have focused on some of the larger animals, the vertebrates. Today is your chance to focus on the smaller animals. Remember, arthropods are animals! You can't make this point often enough. Briefly discuss the difference between insects, spiders, centipedes and millipedes. *Where do you think you will find arthropods? Do you expect to find different species in different locations?*



- ♣ Define the area for the activity. It can be “stay between this path and the river” or “within ten paces of this path” or whatever is appropriate. Many areas in the bosque look alike and if separated from the group, students can get disoriented and feel lost.
- ♣ Remind students that these animals are living creatures and we are in their homes. Treat them very gently. Explain how to use the equipment.
 - **Bug boxes:** Spot an insect on the ground or on a plant, carefully encourage it to go in the box (or jar) and quickly put the cover on. Look at it with a magnifying lens. Pass it around for other students to see. Return it to the area where it was caught.
 - **Insect nets:** Sweep the net through plants or grasses, then tip the rim of the net sideways or up-side down so the rim closes the net; inspect to discover what has been caught. To get a better look, ease a jar and cover into the net, to capture some of the bugs and get a better look at them. Always return the arthropods to the place where they were caught. Insect nets must be returned free of any debris. Sometimes the sweep collects mostly grass seeds, so students must take the time to clean the net.
- ♣ Divide the class into groups of three students. Provide each group with two or three bug boxes and a net, if available. Let students explore for at least 15 minutes. Wander among groups to help them identify their finds. In field journals or on a piece of paper, make a list of the animals collected. Students should draw one or more of the animals captured.
- ♣ Here are some collecting tips:
 - Look in a variety of microhabitats: under rocks, in rotting logs, in bushes, in the bark and along the branches of trees, in grass, down in the leaf litter on the ground – look everywhere!
 - Keep track by noting in journals which microhabitat each creature was found in. You might set up a chart with specific microhabitats (describe or draw) and record captures found in each.
 - When looking under rocks or wood, roll the rock towards you; this reduces the chance of getting bitten by something hiding underneath—it will strike toward the opening, which is away from you. Always return the rock to the same resting spot. Why? Animal homes are underneath.
 - Do not collect wasps, bees, or black widow spiders; all can give a painful sting or bite and some students may be allergic to them.
 - It is best not to handle arthropods directly with your hands. This is especially important for moths and butterflies, as their wings may easily be damaged. Use a bug box or jar instead.
 - Emphasize putting creatures back where they were found and treading lightly on the ecosystem.



- ♣ Call the groups together in a large circle. Have the students pass their bug boxes around the circle so everyone gets a chance to see what was caught. Provide interesting tidbits of natural history related to the creatures collected. Record arthropods captured for all of the groups in journals.
- ♣ Introduce the concept of habitat (the arrangement of food, water, shelter or cover and space suitable to animals' needs). Assuming you are in the bosque, you are in a riparian habitat, but each arthropod will have its own particular microhabitat. Have students describe the specific microhabitat for each of the types of arthropods caught, i.e., grass, large tree, under leaves on the ground, etc. *What does each location tell us about the microhabitat requirements of the arthropod? Would you expect a given arthropod to be able to survive in a different microhabitat? Why or why not? What would happen if the microhabitat were to disappear?* **(3.LS2.C; 3.LS4.C; 3.LS4.D; MS.LS2.C)**
- ♣ After the discussions, have students release their catches in the same place they were found.

Assessment: Use field notebooks to indicate participation and learning.

Extensions:

- Do the *Bosque Bugs Boogie* activity.
- Discuss what contributions arthropods make to the ecosystem (food chain, soil aerators, seed planters, pollinators and so on). *What contributions do insects, spiders, and other arthropods make to humans?* (seed planters, pest control, food producers) Note that sometimes, a species might not seem to benefit humans directly (such as mosquitoes), but it might play an important role in the ecosystem (mosquitoes are pollinators, and they provide an important food source for dragonflies, birds, bats and more).
- Pick one of the arthropods discovered in the bosque. Research specific habitat needs for this species. Create a poster, model, etc. to share this information with the class.
- Take pictures of arthropods found; post sighting data, along with the photos, on iNaturalist / Seek or other bug identification app. Learn about other arthropods observed in your study area.
- For older students, look at arthropods under a field microscope. Draw the body parts and details observed. Try to figure out how these physical adaptations help them. **(4.LS1.A; Structure & Function)**

Reference:

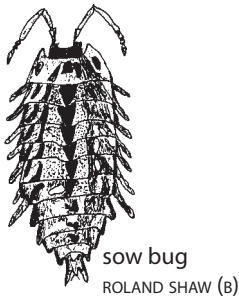
Appendix E: Arthropods

A Field Guide to the Plants and Animals of the Middle Rio Grande Bosque,
Jean-Luc E. Cartron, et al. 2008. University of New Mexico Press, Albuquerque.

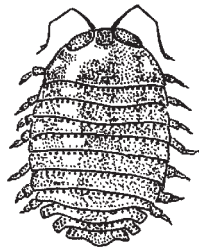
Surface-active Arthropods



Here are drawings (not to scale) and descriptions of some common surface-active arthropods encountered in pitfall traps in the Rio Grande bosque. (Specialized terms and species names in *italics*. Artists: B=Bosque School student; M=New Mexico Museum of Natural History & Science; E= Ernie Pyle Middle School student)



sow bug
ROLAND SHAW (B)



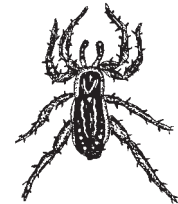
pillbug
CLAIRE EBERT (B)

Class: Crustacea
Order: Isopoda pillbugs or roly polys
and sow bugs or woodlice

While most isopods are marine some, such as the widely distributed pillbugs (“roly polys”) and sow bugs (woodlice), are terrestrial. All have somewhat flattened and multi-segmented bodies. Actually, none are either bugs or lice. Terrestrial isopods have 14 legs used for walking and crawling. In the bosque there are two species: a pillbug (*Armadillidium vulgare*) that rolls into a ball when stressed and a sow bug (*Porcellio laevis*) that cannot. Both species, like nearly all of their relatives, are scavengers and require moist habitats.

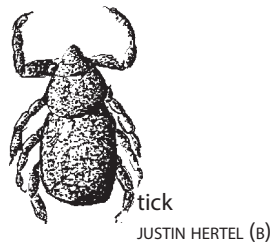


black widow spider
WILL COUTRET (B)

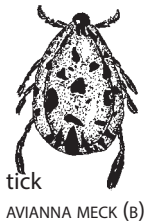


spider
LAURA ROSENBERG (B)

Class: Arachnida
Order: Araneae..... spiders
Spiders and other arachnids have two obvious body sections: The *cephalothorax* (combined head and thorax) supports eight walking legs, a pair of *chelicerae* (or “jaws,” often contain claws or fangs) and the *pedipalps* (primarily sensory organs). The second body section is the *abdomen*, which in spiders contains the silk-spinning *spinnerets*. Spiders are predators of other arthropods, which they pierce with their chelicerae. They externally digest their prey into a liquid state, then suck out the tissues. Spiders and other arachnids come in many body styles, sizes, and colors.



tick
JUSTIN HERTEL (B)



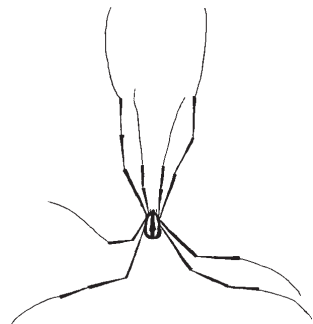
tick
AVIANNA MECK (B)

Order: Acarina ticks and mites
With eight-legged adults and what appears superficially as a single body unit, mites and ticks range in size from tiny to as large a human fingertip. Many are parasites of animals and plants. Many others are predators, especially of other arthropods, or are scavengers. Many mites found in the bosque are brown or nearly white, while some are bright red. It is no exaggeration to say that mites are almost everywhere.

Order: Opiliones harvestmen or
daddy-long-legs

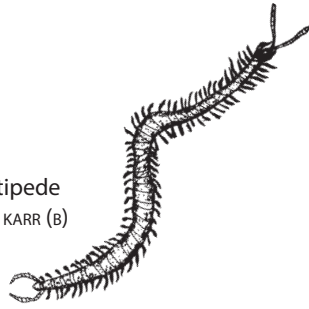
Most people recognize daddy-long-legs by their eight long legs, which except for their apparently unsegmented body make them resemble pholcid spiders (which also live in the bosque). Most harvestmen are predators; however, some are scavengers.

daddy-long-legs
TRAVIS LAY (B)





centipede
EVAN KARR (B)



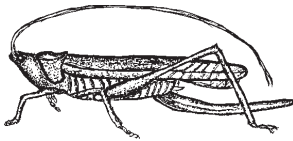
Class: Chilopoda..... centipedes
Centipedes are flattened and have many body segments, each with one pair of legs. They are usually brown, tan, or yellowish. The head bears antennae, and just behind and to the side of the head is a pair of poison fangs. Occasionally one finds small brown centipedes in the bosque. The large local centipede species in the bosque is *Scolopendra polymorpha*. Like other centipedes, it is mainly a predator of other arthropods. Handle it carefully: it moves very fast and has a painful bite.



millipede
JAY KORY JOHNSON (B)

Class: Diplopoda..... millipedes
Unlike centipedes, millipedes have two pairs of legs per rounded body segment. They move slowly and smoothly, using their short antennae to sense to check for environmental information. Millipedes eat mainly dead vegetation and are not poisonous, but many species secrete foul-smelling chemicals from abdominal glands.

grasshopper
BROOKE KARLER (B)



Class: Insecta
Order: Orthoptera..... grasshoppers, crickets and other groups

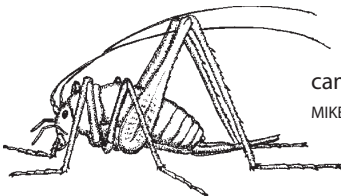
Grasshoppers and their relatives are common in the bosque. Adults of these and most insects bear six legs and a pair of wings on the thorax, which is behind the head and in front of the abdomen. The often colorful hind wings are held lengthwise along the back and are covered by the more drab and leathery front wings. Grasshoppers themselves are of many colors—including brown, tan, yellow, and green—that can match background colors. Grasshoppers are essentially herbivores and chew plant material with their strong mandibles.



field cricket
KENDRA CROWLEY (B)

Crickets and their close relatives are mostly nocturnal scavengers. The common field cricket is black in color with large hind legs and long antennae. The brownish tan or gray camel crickets have long, curved antennae and an arched back. They often hide under logs and stones or in dark moist places. The Jerusalem cricket, or child of the earth, has a large head with powerful jaws that can cut plant roots and unwary fingers. Its antennae are short. The rest of its body other than its tan legs is pale yellowish with dark stripes. It spends much of its day in loose soil.

field cricket
JUSTIN STEWART (B)

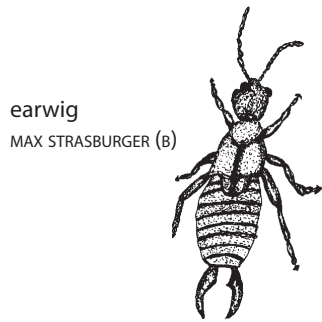


camel cricket
MIKE SANCHEZ (M)

jerusalem cricket
MIKE SANCHEZ (M)



kadydid
KATIE SHAW (B)



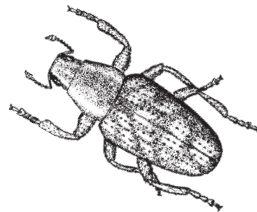
earwig
MAX STRASBURGER (B)

Order: Dermaptera earwigs
Earwigs are identified by their scissors-like pincers (*cerci*) at the tip of the abdomen. Their back wings are folded under very short, hard front wings. Their elongate, rather flat bodies are generally light brown to black in color. Although they do not bite or sting, these mainly scavenging insects can pinch. But they don't get into people's ears, as their name would suggest.

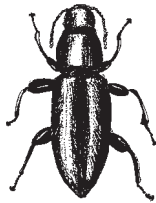


weevil
HELEN HASKELL (M)

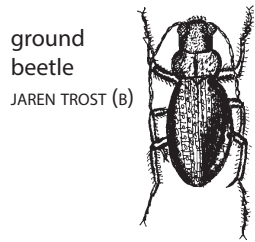
Order: Coleoptera beetles
Beetles, which make up the most species-rich order of animals on earth, are extremely diverse structurally. However, like the orthopterans and earwigs, they have chewing mouthparts, which in the plant-feeding weevils (*curculionids*) are located at the end of a sometimes long proboscis or beak. The hard front wings (*elytra*) of beetles cover the hind wings and abdomen. The generally predaceous ground beetles (*carabids*) tend to be indicators of relatively moist environments. In contrast, the darkling beetles (*tenebrionids*) are often found in drier environments. The rove beetles (*staphylinids*), which range from medium size to quite small, have short elytra that resemble the short front wings of the unrelated earwigs. However, unlike earwigs, rove beetles do not have prominent cerci at the tip of the abdomen. They are mainly predators, not scavengers. Species of these beetle families found in the bosque are often dark in coloration.



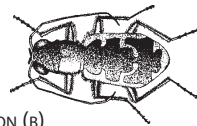
weevil
MIKE SANCHEZ (M)



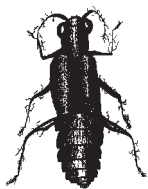
darkling beetle
CAROLYN BARR (B)



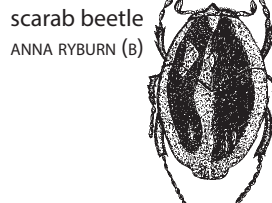
ground beetle
JAREN TROST (B)



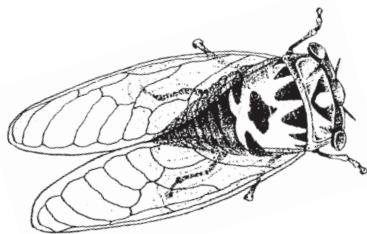
tiger beetle
MAX RICHARDSON (B)



rove beetles
MARIO DELGADO (E)

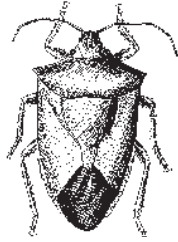


scarab beetle
ANNA RYBURN (B)

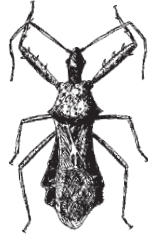


cicada

Order: Homoptera leafhoppers, aphids, cicadas and other groups
Homopterans and the next order, Hemipterans, have sucking mouthparts and are highly variable in body shape and size. The front wings of homopterans are uniform in texture and tend to cover the back like a roof. Mostly plant feeders, these insects keep their short beaks between their front legs when not in use.



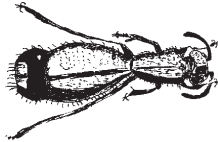
stink bug
HELEN HASKELL (M)



assassin bug
HELEN HASKELL (M)

Order: Hemiptera true bugs
True bugs are have front wings that are relatively thick at the base and membranous at the tip. (The name Hemiptera means "half-wing.") Their feeding habits are highly variable, but most are plant feeders. Stink bugs and squash bugs are among a range of bugs found in the bosque.

velvet ant
JIMMY SCANTLIN (B)



Order: Hymenoptera..... wasps, bees and ants
Ants are the most common hymenopterans in the bosque. They are found on the ground, in bushes, on tree bark, under rocks, etc. They have important and diverse ecological roles world-wide. So-called velvet ants, which are really wasps and can deliver a painful sting, are often seen walking on the ground. They are predators and parasites of other insects.



ant
MARIA SOCHA (B)

NOTE: Bees, wasps, and other flying hymenopterans, may be captured in nets. Use extreme caution when releasing these captures and do not handle directly!

ant
ANNA HEINTZMAN (B)



6. Dip-Net Critters



Description: Students collect and identify aquatic critters in ponds. Teams of students collect aquatic macroinvertebrates and work on identifying them. Secondary students use information on the kinds of critters they find to make general statements about the quality of the water they are sampling

Objective: Students learn:

- to identify aquatic insects from pictures (all students); and
- that aquatic life found in a water body can indicate water quality conditions (secondary students).

Materials:

- White bowls or pans: one pan per team (use shallow yogurt, cottage cheese or tofu containers, ice cube trays, petri dishes, etc.)
- Strainers or dip-nets: one per team (2-3 inch/5-10 cm diameter work fine)
- Wading shoes (old shoes or fishing waders; have towels and dry shoes and socks for after)
- Magnifying lenses: one per team
- Save Our Streams Stream Insects and Crustaceans identification pages: copy one set per team
- Field notebooks and pencils
- Optional: field microscope, small specimen dish that will fit under the scope

Phenomenon: Many tiny animals live in rivers and ponds.

Lesson Questions:

- Which aquatic macroinvertebrates can we find?
- What does the presence of certain aquatic macroinvertebrates tell us about water quality?

6. Dip-net Critters



Grades: 5–12

Time: 45–60 minutes for collecting and identifying

Subject: science

Terms: aquatic macroinvertebrate, collector, detritus, filter-feeder, organic material, predator, scavenger, scraper, shredder



New Mexico STEM Ready! / Next Generation Science Standards

NOTE: see **NGSS Connections to *Going Out: Field Activities*** at the end of this chapter for more possible field trip NGSS connections and for suggestions using each standard.

NGSS DCIs

- 1.LS1.A Structure & Function
- 1.LS1.B Growth & Development of Organisms
- 3.LS1.B Growth & Development of Organisms
- 3.LS4.C Adaptation
- 4.LS1.A Structure & Function
- MS.LS2.C Ecosystem Dynamics, Functioning, & Resilience
- MS.ESS3.C Human Impacts on Earth Systems*
- HS.LS2.C Ecosystem Dynamics, Functioning, & Resilience

NGSS CCCs

Patterns; Cause & Effect*; Systems & System Models; Structure & Function; Stability & Change

NGSS SEPs

Analyzing & Interpreting Data; Constructing Explanations & Designing Solutions, Engaging in Argument from Evidence*

*indicates extension activity

Background:

Searching for and finding bugs is great fun for students of all ages. Young children especially love looking for small living creatures. Capture that enthusiasm with this activity.

Scurrying along the surface, under rocks and across the bottoms of virtually every stream, river, ditch, or pond in New Mexico are a myriad of small insects and other invertebrates. These organisms are collectively known as “**aquatic macroinvertebrates**” because they are animals with exoskeletons that live in the water and can be seen without the use of microscopes. Many of these insects living in or under the water are the larval stages, while the adult versions emerge into flying insects that live above the water. Examples include dragonflies, damselflies, stoneflies, caddisflies, mayflies, mosquitos, and more.

In the Middle Rio Grande Valley, it may be difficult to find small aquatic critters in the Rio Grande, and conditions are often unsafe for children; the same can be said for ditches and many drains. If you have a safe location such as a pond, or very slow, shallow water, this can be safe and fun. Some aquatic species need these slower moving waters to survive. The Discovery Pond at the Rio Grande Nature Center provides good habitat and safe conditions, but requires scheduling with Nature Center staff.

Small creatures living in water provide an entirely new world to discover. They have different ways to move, may live on the bottom or on the surface. Consider questions such as: *How do they move? How do they get oxygen? Do they live their entire lives in the water? What do they eat?* There is an entire ecosystem to discover in a pond. **(3.LS4.C; 4.LS1.A)**



Young students can collect and then carefully look closely at the creatures they find, use the accompanying sheets to identify them, and keep track of what they find.

Secondary students can use the Save Our Streams Stream Insects and Crustaceans identification pages to take their learning further by using the species found as indicators of water quality.

Measuring water quality parameters like pH or dissolved oxygen is essentially like taking a “blood test” of the river. Water quality parameters tell us how “healthy” the river and its surrounding ecosystem are. Getting accurate measurements of water quality parameters is difficult, often involving expensive equipment and complex procedures, but sampling the aquatic life is another way to gauge water quality. Water sample analysis describes conditions at one point in time for the waterway; the creatures found in the water reflect its long-term condition. **(MS.LS2.C; MS.ESS3.C; HS.LS2.C; Stability & Change)**

To understand these aquatic animals, focus on their roles in the ecosystem, especially what and how they eat. In water bodies, there is a constant input of leaves, twigs, and other **organic materials** from surrounding vegetation. **Aquatic macroinvertebrates** thrive on this **detritus**, or dead plant material. Some animals, known as **collectors**, trap bits of organic matter such as leaf fragments, bacteria, and the wastes of other animals upon which they feed. Some collectors are **filter feeders**, like clams or blackfly larvae. **Shredders** cut up and eat leaves, aquatic plants and other larger materials. Some stonefly and caddisfly larvae, sowbugs and scuds feed in this manner. On rocks in rivers you can find **scrapers**. These insects hold on, despite powerful currents, to graze on algae attached to stones and other surfaces. Many of these organisms are flat to help them avoid being pulled downstream. Scrapers include water pennies, limpets and snails, midge larvae and certain mayfly larvae. All of these invertebrates fend off **predators** such as the dobsonfly larvae, dragonfly larvae or fish.

Some aquatic macroinvertebrates can tolerate high levels of sediments and other pollution. Other aquatic creatures are quite intolerant to low levels of pollution. By collecting and identifying what aquatic life is present in the water, we can make some inferences on the quality of the habitat for that area. **(MS.LS2.C; HS.LS2.C; Patterns; Stability & Change)**

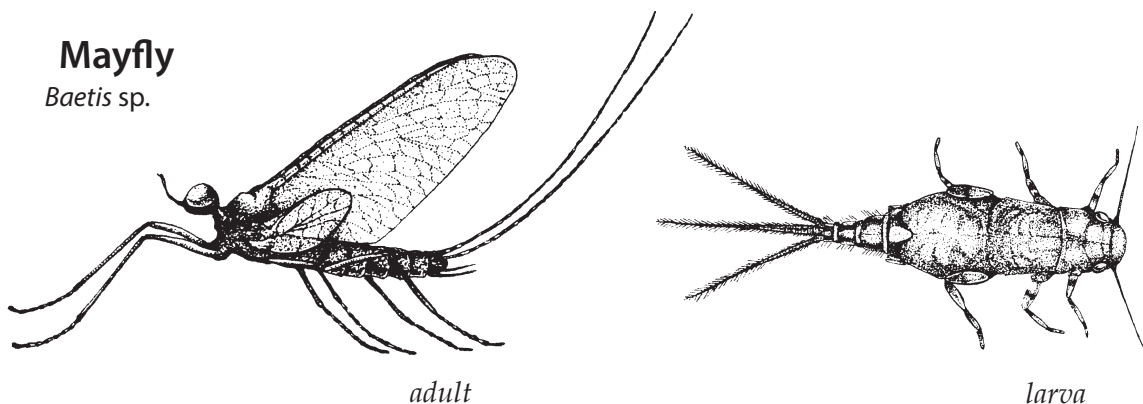
The variety of insects present in a waterway varies with the depth, bottom materials, flow rate and other environmental factors. Many aquatic macroinvertebrates that live in “high quality” waters are found in small, clear mountain streams, and we would not expect to find them in the Middle Rio Grande, even before major human alterations. A valuable approach to interpreting aquatic macroinvertebrate studies on water bodies in the bosque is to compare results with various sampling sites and at various sampling times.



Procedures:

SAFETY CONCERNS: Outline safety rules for this location and activity. Most collecting can be done from the bank; never have students sample in water that is deeper than their knees.

- ♣ Divide into teams of two, three or four. Provide dip nets and white containers to each team.
- ♣ Look for living creatures in the area. Sample from bottom sediment, clinging to vegetation, in the top of the water column, etc. Much can be learned from observing behavior from the bank in clear, calm water. Then use strainers to pick some up and put in white containers with some water.
- ♣ Examine insects or other invertebrates in the containers / trays. *How do they move? Can you tell how they get oxygen?* Diving beetles get a bubble of air and take it down to the bottom to breathe as it works; mosquito larvae have “butt snorkels” to get oxygen at the surface; dragonfly larvae have internal gills to breathe underwater. (1.LS1.A; 3.LS4.C; 4.LS1.A; **Systems & System Models; Structure & Function**)
- ♣ Identify what you can from the Save Our Streams card and draw and record the numbers of each type of animal you find. Draw and record any animals you cannot identify and list the taxa as “unknown” in field notebooks. Try to keep track of different unknowns, such as “Unknown Critter 1,” “Unknown Critter 2,” etc., so you can count how many of each you find.
- ♣ After invertebrates are identified and recorded, return them to the location where they were collected.
- ♣ Older students should note pollution tolerance of each kind of invertebrate found. Use the identification sheets to determine pollution tolerance of each taxon.
- ♣ Back in the classroom, secondary students should analyze the data and represent it as appropriate.



**Assessment:**

- Primary students: Use field notebooks to indicate participation and learning.
- Secondary students: Look at the groups of insects on the Save Our Streams cards. They are listed by tolerance to pollution. *What groups of insects are represented in the students' data? What can students infer about the quality of the habitat based on the aquatic arthropods present?* Make claim, evidence, reasoning statements regarding their data. **(MS.LS2.C; HS.LS2.C; Constructing Explanations & Designing Solutions)**

Extensions:

- Sample at different locations. Have students compare any differences in their collections between sites. Look at the groups of insects on the Save Our Streams cards, they are listed by tolerance to pollution. *What groups of insects are represented in the students' data?* **(Patterns)**
- For larvae found, discuss and look at images of the adult form, and how their habitat needs and lifestyle differ between the two stages (dragonfly and damselfly larvae are great for this). **(1.LS1.B; 3.LS1.B; Patterns)**
- Have students research the life history of any of the animals they found.
- Have students examine the macroinvertebrates under a field microscope or hand lens.
- Have students construct an argument with evidence about how one of the organisms is able to live/survive in the water. **(3.LS4.C; Cause & Effect; Engaging in Argument from Evidence).**
- Do the “*Energy in Bosque Ecosystems*” activity in this *Guide*. Several aquatic food chains are used to illustrate how chemical potential energy moves through an ecosystem using appropriate vocabulary. Have students draw a food chain based on at least one organism they identified on their field trip and label the energy transfers with the correct terms.
- Collect water quality data, such as acidity, dissolved oxygen content and turbidity, at invertebrate sampling locations. Tools include pH strips or tablets, dissolved oxygen tablets, and secchi disks to measure turbidity. Compare water quality results to invertebrates found to assess physical conditions they can tolerate. Learn about sources of pollution that can impact the invertebrates found and the water quality of where they live. **(MS.ESS3.C)**

References:

For more information refer to the Izaak Walton League; they have several online aquatic macroinvertebrate identification keys and guides for younger and older students as well as more information on macroinvertebrate pollution sensitivity. www.iwla.org

Stream Insects & Crustaceans

GROUP ONE TAXA

Pollution sensitive organisms found in good quality water.

- 1 **Stonefly: Order Plecoptera.** 1/2" - 1 1/2", 6 legs with hooked tips, antennae, 2 hair-like tails. Smooth (no gills) on lower half of body. (See arrow.)
- 2 **Caddisfly: Order Trichoptera.** Up to 1", 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock or leaf case with its head sticking out. May have fluffy gill tufts on underside.
- 3 **Water Penny: Order Coleoptera.** 1/4", flat saucer-shaped body with a raised bump on one side and 6 tiny legs and fluffy gills on the other side. Immature beetle.
- 4 **Riffle Beetle: Order Coleoptera.** 1/4", oval body covered with tiny hairs, 6 legs, antennae. Walks slowly underwater. Does not swim on surface.
- 5 **Mayfly: Order Ephemeroptera.** 1/4" - 1", brown, moving, plate-like or feathery gills on sides of lower body (see arrow), 6 large hooked legs, antennae, 2 or 3 long, hair-like tails. Tails may be webbed together.
- 6 **Gilled Snail: Class Gastropoda.** Shell opening covered by thin plate called operculum. When opening is facing you, shell usually opens on right.
- 7 **Dobsonfly (Hellgrammite): Family Corydalidae.** 3/4" - 4", dark-colored, 6 legs, large pinching jaws, eight pairs feelers on lower half of body with paired cotton-like gill tufts along underside, short antennae, 2 tails and 2 pairs of hooks at back end.

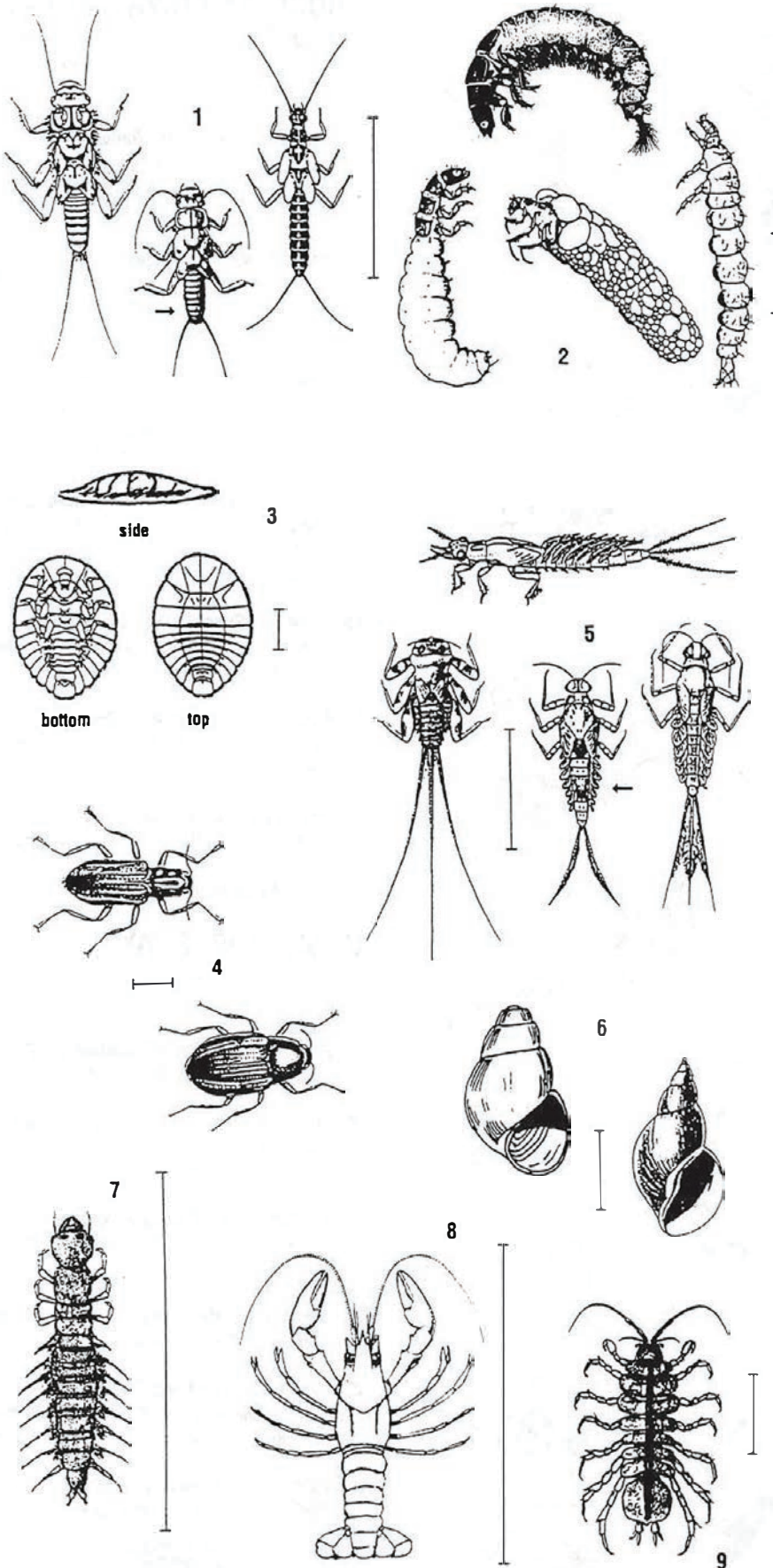
GROUP TWO TAXA

Somewhat pollution tolerant organisms can be in good or fair quality water.

- 8 **Crayfish: Order Decapoda.** Up to 6", 2 large claws, 8 legs, resembles small lobster.
- 9 **Sowbug: Order Isopoda.** 1/4" - 3/4", gray oblong body wider than it is high, more than 6 legs, long antennae.

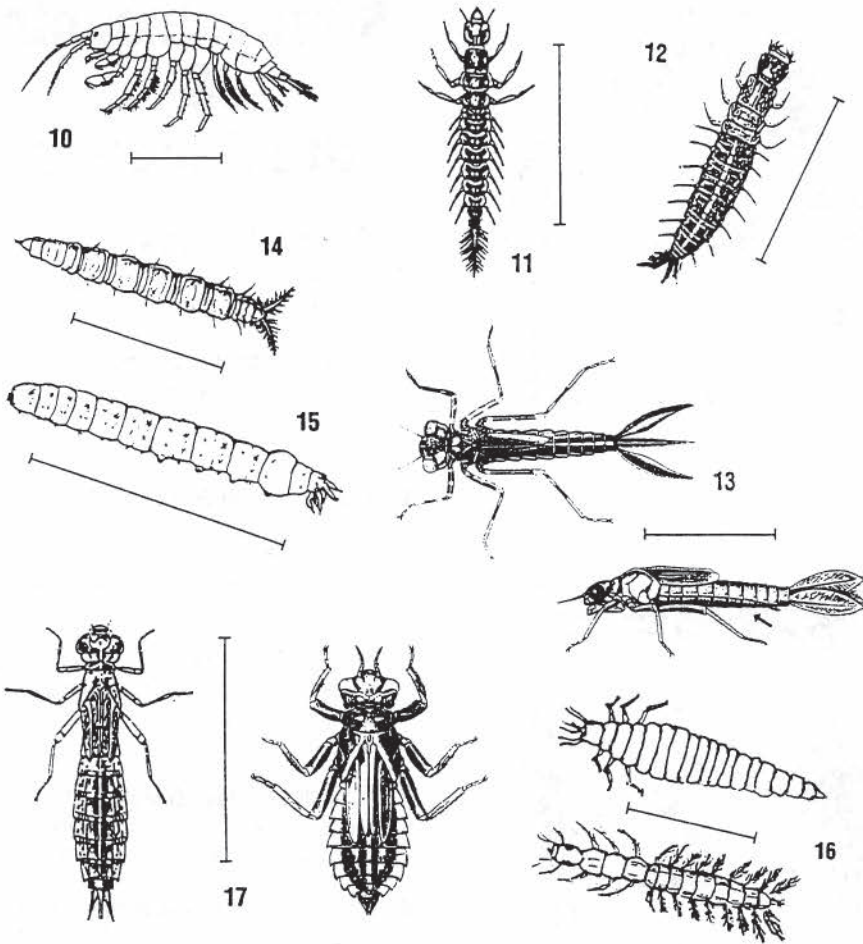
Save Our Streams

Izaak Walton League of America
707 Conservation Lane
Gaithersburg, MD 20878-2983
1(800)BUG-IWLA



Bar lines indicate relative size

GROUP TWO TAXA CONTINUED



10 Scud: Order Amphipoda. 1/4", white to grey, body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.

11 Alderfly Larva: Family Sialidae. 1" long. Looks like small hellgrammite but has 1 long, thin, branched tail at back end (no hooks). No gill tufts underneath.

12 Fishfly Larva: Family Corydalidae. Up to 1 1/2" long. Looks like small hellgrammite but often a lighter reddish-tan color, or with yellowish streaks. No gill tufts underneath.

13 Damselfly: Suborder Zygoptera. 1/2" - 1", large eyes, 6 thin hooked legs, 3 broad oar-shaped tails, positioned like a tripod. Smooth (no gills) on sides of lower half of body. (See arrow.)

14 Watersnipe Fly Larva: Family Athericidae (Atherix). 1/4" - 1", pale to green, tapered body, many caterpillar-like legs, conical head, feathery "horns" at back end.

15 Crane Fly: Suborder Nematocera. 1/3" - 2", milky, green, or light brown, plump caterpillar-like segmented body, 4 finger-like lobes at back end.

16 Beetle Larva: Order Coleoptera. 1/4" - 1", light-colored, 6 legs on upper half of body, feelers, antennae.

17 Dragon Fly: Suborder Anisoptera. 1/2" - 2", large eyes, 6 hooked legs. Wide oval to round abdomen.

18 Clam: Class Bivalvia.

GROUP THREE TAXA

Pollution tolerant organisms can be in any quality of water.

19 Aquatic Worm: Class Oligochaeta. 1/4" - 2", can be very tiny; thin worm-like body.

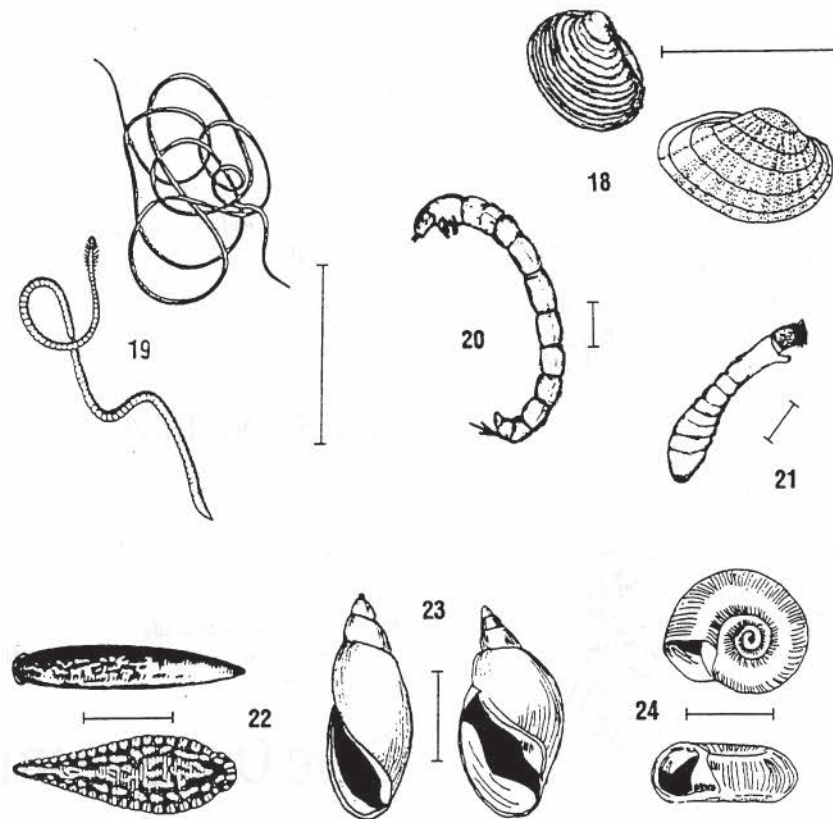
20 Midge Fly Larva: Suborder Nematocera. Up to 1/4", dark head, worm-like segmented body, 2 tiny legs on each side.

21 Blackfly Larva: Family Simuliidae. Up to 1/4", one end of body wider. Black head, suction pad on other end.

22 Leech: Order Hirudinea. 1/4" - 2", brown, slimy body, ends with suction pads.

23 Pouch Snail and Pond Snails: Class Gastropoda. No operculum. Breathe air. When opening is facing you, shell usually opens on left.

24 Other Snails: Class Gastropoda. No operculum. Breathe air. Snail shell coils in one plane.



Bar lines indicate relative size





7. *A Rose by Any Other Name*

Description: Students learn about the process of naming and studying plants by selecting and observing a plant, naming it, and sharing their observations and names with fellow students.

Objective: Students learn:

- that they do not need prior knowledge to identify and enjoy plants;
- about methods of identification and classification of plants;
- some common terms used to describe plants; and
- some methods of plant identification and classification.

Materials: Although this activity can be conducted without any materials, the following items may be useful to have:

- Paper and clipboards
- Colored pencils
- Magnifying glasses or hand lenses
- Copies of student pages
- Field guides to plants

Phenomena: There are many plants growing in this area.

Lesson Question:

- *Can you tell one kind of plant from another?*

7. *A Rose by Any Other Name*



Grades: 4–8

Time: 45 minutes to an hour and half, depending on class size

Subjects: science

Terms: *binomial, genus, scientific nomenclature, species name, variety*



New Mexico STEM Ready! / Next Generation Science Standards

NOTE: see **NGSS Connections to *Going Out: Field Activities*** at the end of this chapter for more possible field trip NGSS connections and for suggestions using each standard.

NGSS DCIs

This activity can be the foundation for many Disciplinary Core Ideas. First, students observe, record, and become able to recognize unique features of a single kind of plant in this activity. Then, expand on this basic understanding of plants' unique features into plants' complex biology and roles in the ecosystem for standards such as: **LS3.A** Inheritance of Traits; **LS3.B** Variation of Traits; **LS4.C** Adaptation; and **LS1.A** Structure and Function, among many others.

NGSS CCCs

Patterns; Structure & Function

Background:

Have you ever wondered why plants have the names they have? Is there anything special about the names of plants? The world of plant names is a fascinating realm to explore. Often, understanding the name(s) of a plant helps us understand and appreciate the plant itself. Cottonwoods are trees (wood) with cottony seeds.

Most plants have several names. The common name is the name most people use for a plant. Each language may have its own common name for an individual plant, and often, especially for plants that have wide geographic ranges, there are several common names for each plant. These common names are also used for different plants, especially in different regions. Using only common names can result in much confusion. Since many plants have important properties, such as medicinal or food uses or toxic properties, it is important to communicate very clearly about which plant you are discussing.

Carolus Linnaeus (1707–1778), a Swedish scientist, developed a system (*Species Plantarum*, 1753) for giving each plant species its own unique name. This name is called the plant's "scientific name" and follows Linnaeus's formula for "**scientific nomenclature.**" The species name, sometimes called a **binomial**, has two main parts: the genus and the specific epithet (descriptor). Other parts of the species name include the author(s) who have first identified the plant and the family name that groups related genera (plural of genus) together.



Common sunflower *Helianthus annuus*
Photograph by Elliott Gordon



The **genus** is the first word in the binomial and is always capitalized. Although it comes first, it is more like a person's last name. The genus describes a group of plants that are related. The second word, or the specific epithet, is unique within that genus to one species of plant. It is usually not capitalized. Both are written in Latin and are *italicized* because it is a foreign language. It is easy to think of the specific epithet like someone's first name. For example, at school there may be several people named Katie, but in a family there is usually only one person with that name. To keep the Katies straight at school, a last name is often used. This is usually the same last name as other members of Katie's family. People familiar with Katie's brother may be able to recognize that she is related to him either by her last name or by similar features.

Plants are like that too. The scientific name for the cottonwood found in the Middle Rio Grande bosque is *Populus deltoides* var. *wislizeni*. The genus *Populus* shows it is a poplar tree; *deltoides* refers to the leaf shape (deltoid or triangular); and the last name is the **variety** (var.), named for Frederick A. Wislizenus, who collected plant specimens in New Mexico in 1846. Different populations of plants within one species are called varieties.

There are several kinds of poplars or cottonwoods that grow in New Mexico. The Fremont cottonwood found in the San Juan and Gila Rivers is *Populus fremontii*. *Populus angustifolia* or narrowleaf cottonwood grows along mountain streams. Another mountain tree is quaking aspen, or *Populus tremuloides*. Although these trees are all in the same genus (*Populus*), they are each individual species. When both the genus and the specific epithet are used together, they are known as the **species name**, such as *Populus deltoides*.

When scientists discover a plant that has not been described before, they get to name the plant. Sometimes they name the plant for themselves or for people they admire. Sometimes they name the plant for some unique features that the plant has. Often the location where the first plant of that species was found is part of the name.

In order for scientists to claim the "discovery" of a new plant, and thus get the honor of naming the plant, they must write and publish a description of the new species. They need to describe what the species looks like, including the features of the flowers, fruits, leaves, etc. They need to explain where it grows and attempt to describe the geographic range of the plant. They need to explain what other plants this new species is related to, and what makes it different from its closest relatives. Originally, this description was written in Latin!



Spear globemallow *Sphaeralcea hastulata*
 photograph by Elliott Gordon



Sometimes more than one person will assign a plant a name. The International Association of Plant Taxonomy governs the process of naming and has rules for resolving naming disputes. There are two codes (The St. Louis code and the Tokyo code) for deciding the proper name. Botanical congresses convene regularly to sort out any confusion.

Botanists have many words to describe very specific features of plants. The “Guide to Observing Plants” in this activity illustrates some of these terms for identifying various plant features, leaf shapes and arrangements, and flower and fruit types. The sidebar defines some common botanical terms.

Procedure:

- ♣ Ask students to name some of the plants they know. *Does anyone know why the plant has that name?* Discuss the kinds of names that plants have (see *Background*).
- ♣ Explain that scientists and explorers sometimes name plants. Today the students are going to be explorers and find “new” plants (actually, it is okay for students to select any plant, but preferably a plant that is new to the student.) They will make up their own names for the plants based on their observations. Once the students find, make observations on, and name a plant, the group will take a “guided nature hike” and every student will get to show their classmates a plant and explain its new name.
- ♣ Designate boundaries for the area where students can search for plants. This could be as simple as “do not get out of sight of this ‘designated landmark’.” Also designate a meeting time and a meeting place for students to return to start the nature hike.
- ♣ The tasks for students are to:

 - Select a plant that they would like to observe.
 - Draw the plant and take notes about it. Students use the “Guide to Observing Plants” student page to help describe the shape and arrangement of its leaves and characteristics of the flower or fruit. Students can also look for clues about where the plant grows. *Does it seem to like the sun or the shade? Does it appear to need lots of moisture? Are there any plants that it seems to grow next to? What does the plant feel like? Does it have a smell? Does it make a noise when the wind blows?*
 - Record at least three interesting observations about the plant.
 - Create a name or names (common and/or scientific, or in other languages) for their plant and describe why they are chose the name.

(Patterns; Structure & Function)



Desert willow *Chilopsis linearis*
photograph by Elliott Gordon



- While students are exploring the designated area and selecting, observing, and naming plants, circulate among the students to assist with individual questions. Most students will need five to 10 minutes for this part of the activity.
- Assemble the group together again and explain that the group is going on a guided nature walk to each person's plant. Ask a student to lead the group to his or her plant. Have the student introduce the group to his or her plant and explain his or her name for the plant. Ask if any other students selected the same kind (species) of plant. *What was their name?* Ask the students to share at least two of the special observations they have made. If you know the plant, you can add additional information about the plant here, but the activity works well without any previous plant knowledge. Ask if any other students have a plant nearby and move on to the next plant until all students have shown and discussed their plant.

Assessment:

Assessment can be based on participation and noting the care and quality of the students' observations.

Extensions:

- Younger students can do crayon leaf rubbings. Label parts of the leaf as appropriate.
- Do the "Who Grows Where?" activity on the *Changing River* model in this *Guide*.
- Students may want to learn more about their plants. With field guides, and even the plant identification cards in the "Who Grows Where?" activity, they can try to identify the plants they have become familiar with on their nature hike. You can invite someone along who knows the plants of an area to teach them to you.
- Use online sites like: iNaturalist, Seek, PlantNet, PlantSnap, LeafSnap, or Google Images. These allow you to take a photo, upload it and their artificial intelligence (AI) software will quickly send an identification, and in some cases will have human verification as follow-up.

Our caution is that when students ask for a name, and get it, often their attention and learning about that organism stops—it is identified. But the real learning comes with observation, noting qualities and relating that organism to its ecosystem.

- Students may want to research the different names for their plants. Most field guides give both the English common name or names and the scientific name. Seek out Spanish names and local Indigenous names for the plants. *Are any characteristics, locations or uses for each plant etc., reflected in its name?* Interviews are another excellent way to collect common names for plants.



- Conduct oral histories with elders to learn more about traditional knowledge of native bosque plants.
- Identify an adaptation of the chosen plant, and think of something humans have created or invented that is used for similar purposes, or have students invent something based on the plant's abilities (i.e. seed attachment for dispersal and velcro). (**Engineering**)

Resources/References:

There are many references to help with plant study and plant identification. Do a search for local field guides as well as student plant identification resources, or the online apps listed under extensions.

Cartron, J.E, et al. 2008 A Field Guide to the Plants and Animals of the Middle Rio Grande Bosque, University of New Mexico Press.

Harris, J.G & M. Woolf Harris. 1994/2001 Plant Identification Terminology: An Illustrated Glossary, Spring Lake Publishing, Payson, Utah.



Guide to Observing Plants

When you are trying to identify a plant, there are several observations you can make. Follow this guide and answer the questions to help you identify your plant.

1. Find a plant.

Is your plant a tree, a shrub, a forb, a graminoid, or other?



If it has a woody base, it is a tree or a shrub.

If it has a woody base and, when mature, it is over 10 feet (3 m) tall, it is a tree; otherwise it is a shrub.

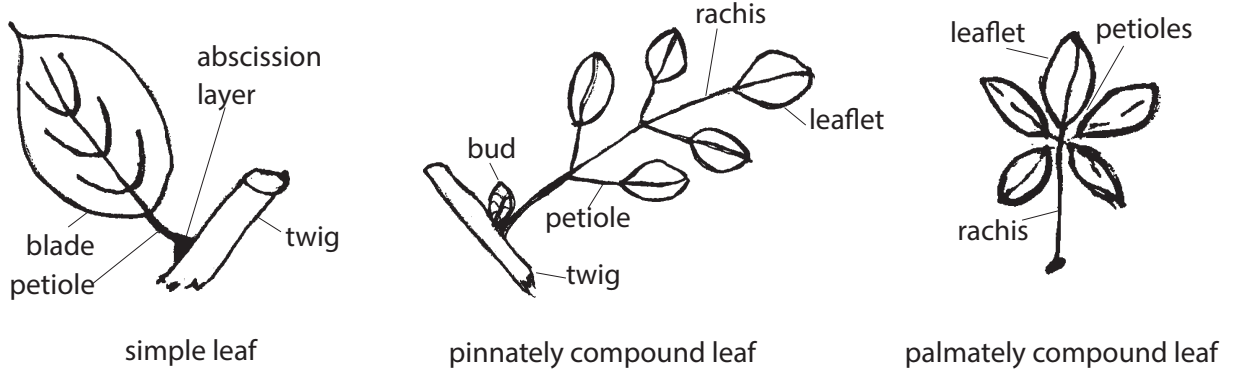
If it does NOT have a woody base and it looks like a grass, call it a graminoid.

If it does NOT have a woody base and it does NOT look like a grass, call it a forb.

If it doesn't fit any of these categories, call it other.

2. Look closely at the leaves.

Identify the basic leaf parts: blade, leaflets (if compound), petiole, etc. Determine if your leaf is simple or compound. If it is compound, is it pinnately compound or palmately compound?

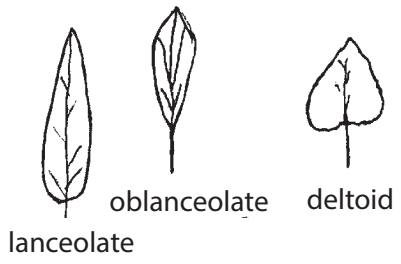
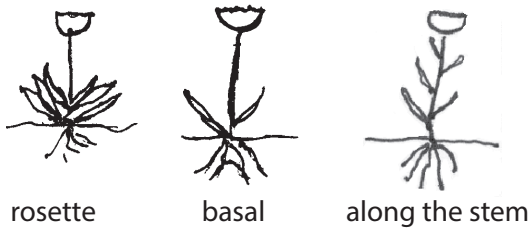


3. How are the leaves arranged on your plant?

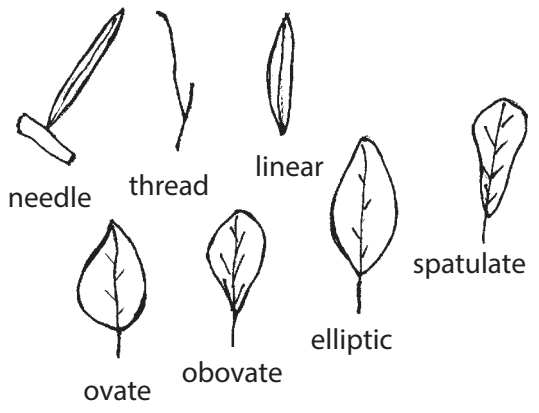




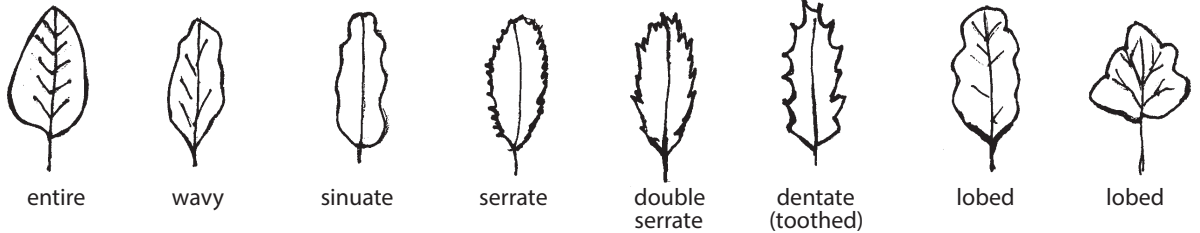
4. If your plant is a forb, where do the leaves grow?



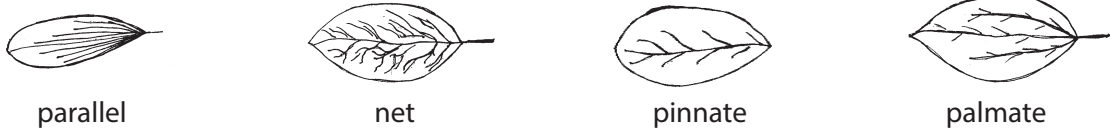
5. Draw your plant's leaves.
What shape is your leaf (or leaflets)?



6. What kind of margin (or edge) does your leaf have?



7. What kind of pattern do the veins in your leaf make?



8. Write three observations about your plant:

9. Name your plant: _____

Why did you choose this name:



Common Botanical Terms

Botanists use many special words to describe plants in very precise ways. Many of these words are very specific to distinct features, so they are not used in normal conversation. They are true English words, though (and legal for use in Scrabble®!).

Here is a list of some of the more common botanical terms that are used in this Guide to Observing Plants. (Primarily from *Plant Identification Terminology: An Illustrated Glossary*)

Growth Types:

tree: a large, woody plant that at maturity is over 10 feet (3 meters) tall

shrub: a woody plant, usually with several stems, that is generally under 10 feet (3 meters) tall

herb: a non-woody plant; stems die back to the ground at the end of the growing season;
herbs include graminoids and forbs

grass: an herb that is in a family of plants that has jointed, tubular stems, leaf parts that include a sheath, ligule, and blade, and modified flowers that produce grains

graminoid: an herbaceous plant that either is a grass or looks like a grass

forb: a non-grass like, herbaceous plant

Leaf Characteristics:

simple: undivided, as a leaf blade not separated into leaflets

compound: with two or more parts in one organ

opposite: having two parts across from each other at each node, as in leaves on a stem

alternate: having only one part at each node, as in leaves on a stem

blade: the broad part of a leaf or petal

petiole: a leaf stalk

rachis: the main axis of a structure, such as a compound leaf or an inflorescence (cluster of flowers)

abscission layer: a thin wall of cells at the base of the leaf petiole that breaks down and causes the leaf to fall

node: the position on the stem where leaves or branches originate

internode: the portion of the stem between two nodes

rosette: a dense, radiating cluster of leaves

basal: positioned at or arising from the base, as leaves arising from the base of the stem

clasping: wholly or partly surrounding the stem

pinnate: resembling a feather, as in a compound leaf with leaflets arranged on opposite sides of an elongated axis

palmate: divided from a common point, like fingers on a hand

lanceolate: lance-shaped; much longer than wide, with the widest point below the middle

oblanceolate: inversely lanceolate; much longer than wide, with the widest point above the middle

deltoid: with the shape of the Greek letter delta; shaped like an equilateral triangle

needle: a slender, needle-shaped leaf, as in pine trees

thread: a thin leaf, like a thread without fleshy tissue on each side of the blade

linear: resembling a line; long and narrow with more or less parallel sides



ovate: egg-shaped in outline and attached at the broad end

obovate: egg-shaped in outline and attached at the narrow end

elliptic: in the shape of an ellipse, or narrow oval; broadest in the middle and narrower at two equal ends

spatulate: like a spatula in shape, with a rounded blade above gradually tapering to the base

sinate: with a strongly wavy margin

serrate: saw-like, toothed along the edges, the sharp teeth pointing forward

dentate: toothed along the margin or edge, the teeth directed outward rather than forward

lobed: bearing rounded divisions or segments which are cut less than half-way to the base or mid-vein

net-veined: in the form of a network; reticulate

Flower Parts:

flower: the reproductive part of a plant

petal: generally the showy, colored part of a flower, yet determined by position in relation to other plant parts (i.e., above the sepal)

sepal: the outer parts of a flower, typically a green bract that is below the colored petal

stamen: the male reproductive organ in a flower, consisting of a stem called a filament and the head called the anther which contains the pollen

pistil: the female reproductive organ in a flower, consisting of the ovary where the seed develops, the stigma where the pollen enters, and the style that transports the pollen from the stigma to the ovary

Life Cycle:

annual: a plant that grows from a seed, flowers, sets seed, and dies in the same year

biennial: a plant that lives two years, usually forming a basal rosette of leaves the first year; the second year it flowers and fruits, and then dies

perennial: a plant that lives three or more years





Description: Students interpret the bosque on a field trip using individual informational clue cards.

Objective: To help students learn to observe and make inferences from their observations about the ecological processes in the bosque.

Materials:

- Photocopies of clue cards
- Field journals, pencils
- Appropriate field trip equipment (See *Planning a Bosque Field Trip*, in Chapter 3 Going Out: Field Activities)

Phenomena: I can discover many things about the bosque (or other natural area) if I make careful observations. I can discover clues that will tell me about the plants and animals that live here now, lived here in the past, and will live here in the future.

Lesson Questions:

- *Why are there piles of dirt on the ground?*
- *Why are pieces of the bark missing on that cottonwood tree?*
- *Why is saltbush growing in the bosque?*
- *How did that tree get mud rings around its base?*

8. Reading the Bosque



Grades: 4–12

Time: one field trip to the bosque, about two hours

Subjects: science


Terms: *arson, cambium, cohort, debris, germinate/germination, larvae, meander, overbank flooding, photosynthesize, riparian, scat, sediment, semi-parasitic, snags, sucker, water table*



New Mexico STEM Ready! / Next Generation Science Standards

NOTE: see **NGSS Connections to *Going Out: Field Activities*** at the end of this chapter for more possible field trip NGSS connections and for suggestions using each standard.

NGSS DCIs and New Mexico State Performance Expectations

- 1.LS1.B Growth & Development of Organisms
- 1.LS1.D Information Processing
- 3.LS1.B Growth & Development of Organisms
- 3.LS2.D Social Interactions & Group Behavior
- 4.LS1.A Structure & Function
- 4.LS1.D Information Processing
- 5.LS1.C Organization for Matter & Energy Flow in Organisms
- 5.LS2.A Interdependent Relationships in Ecosystems
- 5.ESS3.C Human Impacts on Earth Systems
- MS.LS2.A Interdependent Relationships in Ecosystems
- MS.LS2.C Ecosystem Dynamics, Functioning and Resilience
- MS.LS4.D Biodiversity and Humans
- MS-ESS3-3 NM PE Human Impacts 
- MS.ESS3.C Human Impacts on Earth Systems 
- MS.ESS3.D Global Climate Change

NGSS CCCs

Patterns; Cause & Effect; Energy & Matter: Flows, Cycles, & Conservation; Stability & Change

NGSS SEPs

Asking Questions & Defining Problems; Constructing Explanations & Designing Solutions;
Engaging in Argument from Evidence*

*indicates extension activity

Background: When we read, we interpret many symbols (letters) that make up the words. The words make up sentences that express ideas. Reading is a process of understanding others' written thoughts by making sense of many smaller symbols. We use reading or decoding skills in other areas as well. For example, musical notes on a scale are symbols we translate into melodies and songs.

Naturalists are adept at “reading” the landscape. That means that they can infer what is happening, or has happened, or might happen in the future, by looking at the clues on the landscape and translating them into a larger understanding of the ecosystem. Reading the landscape requires building an understanding about what your observations mean. For example, a person looking at tracks in a trail might say, “Look, an animal walked here.” A more experienced observer might be able to identify the animal based on the shape of the track. An expert might add when the animal came by, what other animals it was with, and maybe even what it was doing. Like any other kind of reading, the more you read the landscape, the better you will become at interpreting what you see. Unlike reading words, landscape reading is not an exact science. People often interpret ecosystem “stories” in different ways. Some students may read the bosque well, even though they struggle with reading words.



As you go through this activity with students, they will develop knowledge and a better understanding of how to “read the bosque,” or how to interpret the **riparian** area (rye-PEAR-ee-an; relating to or living or located on the bank of a natural fresh watercourse such as a river, stream, creek, pond or lake) to tell a story about the past and the present.

Procedure:

- ◆ Introduce the idea that we know things from making observations. For example, if the cereal box is empty, we know that all the cereal is gone. If the sun is streaming through our window and our parents are yelling at us to get up, we know it is morning. Much of what we know about the world around us is gathered by observing phenomena through our senses (sight, smell, hear, taste, touch). Explain that much of what we know about the bosque comes from our observations. By learning what our observations mean, we can know the bosque better.

In reading we use words, linked together in sentences, to share ideas. In reading the bosque landscape, we learn to identify the elements of the bosque, such as a type of plant. Then, we combine those observations to understand a bigger story and learn about the larger ecosystem.



*North American Porcupine eating in
a Russian Olive tree in the Bosque*
Photograph by Laurel Ladwig



- Have students make a KWL chart.

Ask *What do you **Know** about the bosque?* For students who have been to the bosque before, ask what they know based on their own observations.

Ask *What do you **Want** to know, that could be discovered through observation?*

If students are using a Bosque Field Journal, KWL charts may be added to their journals. At the end of the field trip, ask *What have you **Learned** about the bosque, based on your observations?* (**Asking Questions & Defining Problems**)

- Trip to the bosque:

There are 28 Clue Cards. Use one per student or pair of students. A few cards are seasonal, such as when the cottonwoods are sending out seeds covered in “cotton” and it seems like it is snowing, but cottonwood cotton can usually be found year-round if you look. You will be able to use most of the cards at any time of year, but it is best to do a reconnaissance trip to identify cards that will apply on your particular walk.

**Teaching Multiple Subjects
Using a Lacy Leaf**

**Find a Lacy
Leaf and draw
it.**

**Is this leaf from
this growing
season?**

Estimation- MATH
Prediction- SCIENCE
Observation-ART
Story Telling-LANGUAGE ARTS

**Write a story
about where
this leaf has
been.**

**Estimate
how many
holes you
see.**

Use this activity as a jumping off point for many different subjects and standards that you want your students to reach. Above is an example of how you could use the lacy leaf Reading the Bosque card (#9) to teach multiple subjects at once.



Hand out the cards to students and explain that they will be the experts as they walk in the bosque. Each card has an introductory question or “something” to look for. They should read through the text on the card and figure out how to answer that question or what that “something” is. You should go over terms they will be using. As you walk, when they see the item referred to, the whole group should stop and learn from the “expert” about it. They can read the paragraph or, even better, having read it before, they tell the information to the whole group in their own words. Or ask the group their thoughts on the answer to the question and then fill in with extra information from the card.

As facilitator, you may have to stop the group and say, “Does someone have some information about ____?” in order to remind the students that this is a good place to share a particular card.

- If using their Bosque Field Journals, have students record their observations in them.
- Older students may take photos of clues to be shared later as part of research, reflection and /or share-out in the classroom.
- For any age, use clue cards to guide research in the classroom. Provide field guides and other naturalist books for reference.
- Each card includes an **Additional Learning Challenge** for more advanced students. After discussing the main clue at the top of the card, have students read their challenge to the class and offer a possible answer or explanation based on their observations. You may use these challenges to guide research back in the classroom.

🍄 Depending on what you see on any given walk, there are many science standards that can be addressed. Here are some examples. The numbers shown in parentheses indicate the activity cards where each of these may be addressed.

What behaviors do adult birds do to help provide a good start for their young? (12, 13) **(1.LS1.B Growth & Development of Organisms)**

Cottonwood trees send off fluffy tufts carrying seeds to new locations. Look at the challenges of cottonwoods reproducing. (16) **(3.LS1.B Growth & Development of Organisms)**

Look at ants. (4) *How does living in a group help the colony?* **(3.LS2.D Social Interactions and Group Behavior)**. *How do ants communicate with each other?* **(1.LS1.D Information Processing; 4.LS1.D Information Processing)**


What adaptations do pocket gophers have to living underground? (2) **(4.LS1.A Structure & Function)**

Look at the various animals that eat cambium, the inner bark of trees: beaver, porcupine and bark beetles. *How do they each obtain the food that they need?* (1, 6, 11) **(5.LS1.C Organization for Matter & Energy Flow in Organisms; Patterns)**



How did a cottonwood leaf get to be lacy? What organisms depend on them? (9) **(5.LS2.A Interdependent Relationships in Ecosystems)**

Mistletoe is a partial parasite on cottonwood trees. *How does it survive and reproduce?* (20) **(MS.LS2.A Interdependent Relationships in Ecosystems; Energy & Matter: Flows, Cycles, & Conservation)**

Look at ways humans have altered the river and bosque habitat, and consider effects on native plants and animals. (15, 18, 19, 24) Look for marsh plants and consider the impact humans have had on wetlands throughout the bosque ecosystem. (22, 23) Look at a site that has been burned. (10) *How might the actions of humans increase the risk of fire in the bosque, both directly and indirectly? How can we decrease that risk?* **(5.ESS3.C Human Impacts on Earth Systems; MS-L2.C Ecosystem Dynamics, Functioning & Resilience; MS.LS4.D Biodiversity & Humans; MS-ESS3-3 NM PE Human Impacts; MS.ESS3.C Human Impacts on Earth Systems; Cause & Effect** 

Younger Students

If there will only be one trip to the bosque for a group of younger students, then select 3-4 cards and assign a card to each small group to do the research and report back to class. If multiple trips are possible, select one theme for each trip for the class to focus on. For example, use “Looking for stumps,” as a focus for a trip. At each stump students think about what had happened in order for that tree to fall, and the teacher helps the class think through answers.

Suggested cards for younger students: looking for antlion pits, stumps, harvester ant hills, pocket gopher mounds, seasonal signs, bark beetles, jetty jacks, lacy leaves and isopods, tracks and scat. You will need to summarize the information for their level.

Assessment:

Revisit the KWL charts and ask students: *What have you **Learned**, based on your observations?* Record in journals, and/or present to the class. Use unanswered questions based on students’ observations to guide research back in the classroom.

Extension:

Use “**Additional Learning Challenges**” from the cards as research extensions.

Resources:

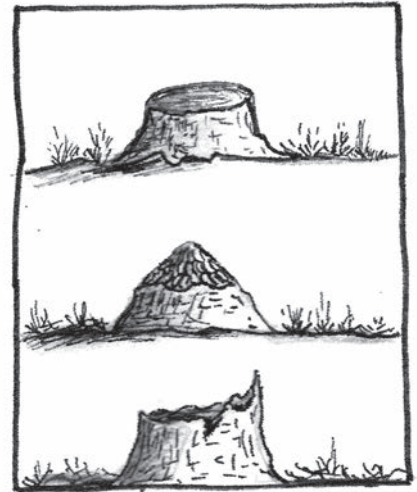
The “Changing River” activity in Chapter 4 will give an overview of the concepts in this activity.

Clue Cards

(1) Stump. Why did that tree fall down?

Look at the surface of the stump.

- If the tree stump is cut straight across and even, it was cut by a person using a saw. Sometimes trees are taken from the bosque for the wood. In some areas a tree might be cut down so that it does not fall on people using a trail or to move it off the trail.
- If the tree has teeth marks along the cut, it was cut down by a beaver. Along the Rio Grande, beavers cut trees to use for food. After the tree falls, if it is a large tree the beavers take off the branches to use, but they will not eat the trunk. For small trees, beavers will take the whole tree. They eat the layer of tissue underneath the bark, called the **cambium** (CAM-bee-um).
- If the stump has jagged edges, the tree blew over, perhaps in a strong wind. This often happens to trees that are already damaged by fires or by drought stress. Often these tree stumps are at different heights because the trees break off at different places.

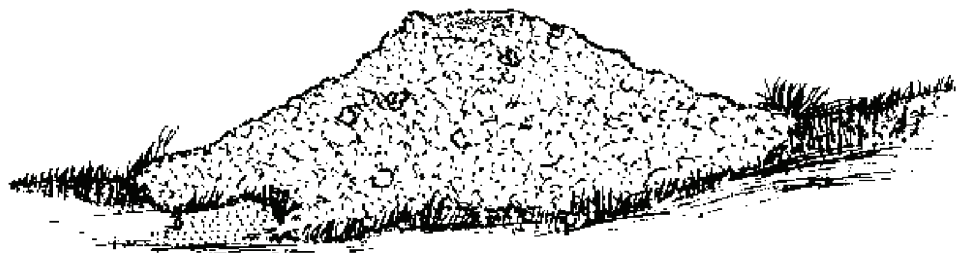


Additional Learning Challenge:

What happens to trees that fall down in the bosque?

(2) Look for piles of soil about 1 foot (30 centimeters) across. What made these mounds?

These are pocket gopher mounds. They are very common in the bosque, because gophers are able to dig easily in the soil near the river. The gopher digs a tunnel underground, then pushes all of the soil that it moved aside to make the tunnel up through the tunnel's hole to the surface. Gophers usually fill in the entrance hole so that predators can't get in as easily, so typically you will not find a hole in the pile of soil. Gophers spend most of their lives underground. Many desert plants have enlarged roots or other underground storage parts that store nutrients and water for the plants. Gophers dig new tunnels to get to these underground parts of plants, which are their favorite foods. Being underground also helps the gopher avoid predators and extreme hot and cold temperatures.



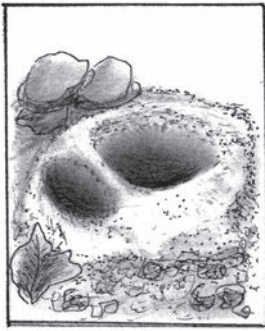
Pocket Gopher Mound

Additional Learning Challenge:

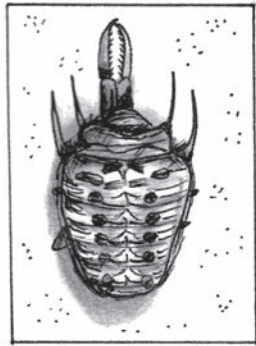
What adaptations do pocket gophers have to life underground?

(3) Look for small pits in the sand—2-inch (5-centimeter) funnel-shaped depressions. What made these pits and what are they for?

A young antlion (also called a “doodlebug”) lives here. Antlion **larvae** (LAR-vey; young insects, which eventually become adults that fly) hide at the bottom of small, conical pits that they make in sand or fine dirt. They wait to catch ants and other small insects that fall into the pit. Antlions have large jaws to catch their prey.



Antlion Pit



Antlion Larvae



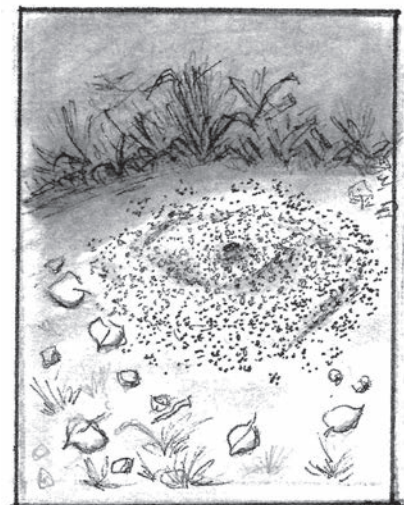
Adult Antlion

Additional Learning Challenge:

What other holes can you find in the bosque? Can you tell what made them?

(4) Look for a mound of sand with a wide circle of bare ground around it. What made that hole? Do you see any ants going in and out of the hole? What are they doing?

This mound with a hole in it was made by harvester ants. Harvester ants build large, underground nests over 9 feet (3 meters) deep with many storage chambers. They eat seeds, which they collect from the area around the nest and then carry underground. Sometimes they also eat other small animals such as isopods, which they sting and carry underground. The ants carefully tend the mound outside the nest. They place bits of dead plant material, small stones, and, sometimes, tiny bits of leaves on the surface of the mound, probably to trap warmth from the sun. Sometimes there are also skeletons from isopods. Often small trails can be seen going out from the nest; worker ants forage along these, looking for seeds. The ants stay underground in winter and eat stored food.



Harvester Ant Hill

Additional Learning Challenge:

What happens when we kill ants or other animals that humans consider to be “undesirable?”

(5) Look high in the trees for a spiky brown ball (bigger than a soccer ball) that looks like a giant nest, but it is not made of sticks. It might even move. What is this?

It is a porcupine! Porcupines are often seen high in cottonwood trees, but they use other trees as well. They are shy and often appear to be sleeping, but sometimes you can see them feeding on tree bark or buds. They are covered by prickly quills, which are really modified hairs. Porcupines cannot shoot their quills. They are easiest to see in winter when the trees have no leaves.



Additional Learning Challenge:
Why do porcupines have spiny quills?

Porcupine Curled up in Tree

(6) Look for trees with large patches of bark missing from trunk or branches with little paired tooth marks, sometimes high in the tree. What caused this?

Porcupines live in trees. In winter, they chew off patches of bark and eat the inner layer of bark, the growing part called the **cambium** (CAM-bee-um). They sometimes chew the bark off all the way around a branch or trunk, but they do not cut the whole tree down the way beavers do. In spring and summer, they may eat new leaves, buds, and twigs. Porcupines often prefer to eat up high where they are safe from predators.



Porcupine



Porcupine Chew

Additional Learning Challenge:
Why do porcupines (and beavers) eat the cambium part of the tree?

(7) Look for tracks that appear to be tiny hands. Who made these tracks?

These tracks were made by a raccoon—they tell you that a raccoon was here. The tracks left by the front feet of raccoons look like small human hands, so they are easy to identify. Raccoons often walk along the mud or wet sand in the riverbed, or along the shore, as they look for food. They like to eat aquatic animals such as frogs and crayfish.



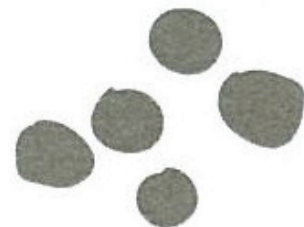
Raccoon Tracks

Additional Learning Challenge:

What other tracks can you find in the bosque and along the river? Can you identify them?

(8) Can you find any animal scat (droppings) and what can you tell from it?

“**Scat**” is a name used by biologists for “poop.” You can tell what animal has been here by the scat it leaves behind. You can also tell a lot about what an animal eats by looking at its scat. For example, coyote scat will have small bones and fur in it if the coyote has been eating mice, or it may contain the hard shells from beetles if that is what the coyote has been eating. Or, it may have berry seeds or other bits of hard plant material. The shape of an animal’s scat can often identify the type of animal. Rabbit scat are round pellets that are filled with plant material. Look in a book of animal signs to learn how to identify scat.



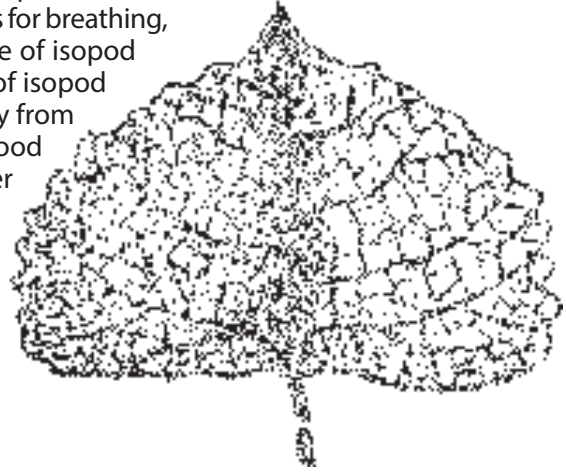
Rabbit Scat

Additional Learning Challenge:

What happens to the scat left behind by animals in the bosque?

**(9) Look at the fallen leaves on the ground. Can you find a “lacy” leaf?
How did the leaf get this way?**

This leaf was eaten by isopods (pillbugs, woodlice). The isopods eat away the soft tissue of the leaf and leave behind the tougher veins, giving the leaf a lacy appearance. Isopods are crustaceans and related to shrimp and crabs. They have gill-like structures for breathing, so they need to be in moist areas. The most common type of isopod in the bosque rolls up when it is disturbed. Another kind of isopod cannot roll up so instead, it moves faster to try to get away from predators. Females can hold as many as 200 eggs in a brood pouch on their undersides. Isopods are the main chewer of fallen cottonwood leaves in the bosque. They start the process of decomposition that is an important part of the nutrient cycle—providing necessary nutrients to plants and animals in the bosque ecosystem.



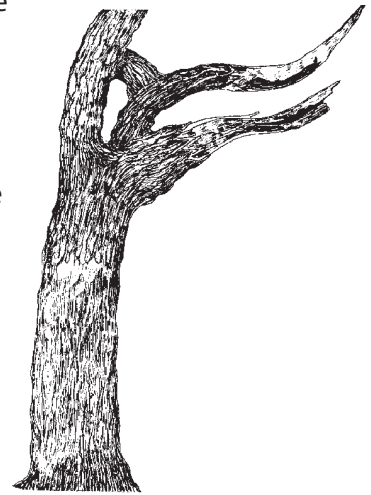
Lacy Cottonwood Leaf

Additional Learning Challenge:

What would happen to the forest if there were no decomposers?

**(10) Do you see any charred stumps or snags (standing dead trees)?
What happened here?**

The site was burned by a fire. Fires may not have been an important part of the bosque before the river ecosystem was changed and flooding was reduced. When the bosque flooded regularly, the wetter ground did not carry fire. The branches that fell off of trees decomposed faster with the added moisture. For instance, a log that might take 70 years to decompose today in our current dry conditions might have taken only 10 years to decompose when there was regular **overbank flooding** that kept the soil moist. This wood from fallen tree branches or standing dead trees (**snags**) now contributes to very hot fires that do a lot of damage in the bosque today. While some burned trees may re-sprout from the stump or roots, very hot fires may kill the tree completely. Most bosque fires are started by humans. Ignition sources include dropped lit cigarettes or matches, fireworks, burning to clear adjacent fields or ditches and intentional acts of arson. Only a small number of fires in the bosque today are started by lightning.



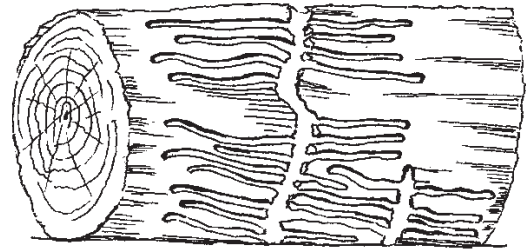
Snag

Additional Learning Challenge:

What can you do to help reduce the risk of fires damaging the bosque?

(11) Inspect fallen logs carefully. Can you find any small trails cut into them where bark is falling off? How did they get there?

The trails were made by bark beetles. Adult bark beetles bore through the bark of a tree and make tunnels between the bark and wood and eat **cambium** (CAM-bee-um), in which they lay their eggs. The young, called **larvae** (LAR-vey), also make tunnels under the bark. Sometimes, if there are enough of them, the beetles can kill a tree by making these tunnels. If the numbers of beetles are low, this will not kill the tree. Trees that are sick or facing drought are more likely to die from bark beetles.



Bark Beetle Trails

Additional Learning Challenge:

How might climate change and increasing drought affect trees exposed to bark beetles?

(12) Look for a nest in a tree. What materials is it made from?

Many types of birds build nests in trees, often using sticks, twigs, grasses and other plant material. Sometimes they include man-made objects, such as plastic bags. They build nests as places to lay their eggs and raise their babies. Nests are often hard to see when the trees have leaves on their branches, but are easy to spot in the winter after trees have lost their leaves. Nests tell us that birds live in the bosque during their breeding seasons. Owls build their nests in winter, but most smaller birds build nests in spring or summer. Sometimes we can tell what type of bird made the nest. Use a field guide to nests to help you discover the builder.



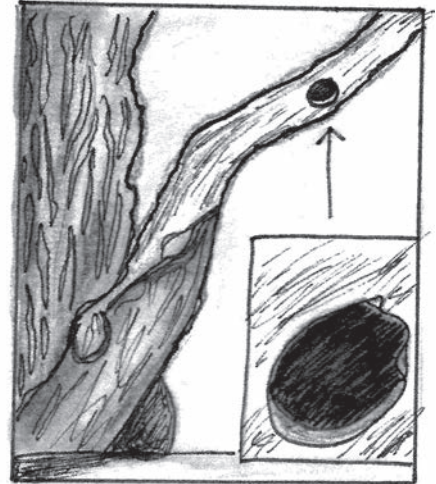
Bird Nest

Additional Learning Challenge:

What will happen to birds that nest in trees if the bosque trees die off due to factors such as drought, decreased seedling survival or fire?

(13) Look for a round hole in a standing dead tree or in a dead branch of a living tree. What is this hole and what made it?

Woodpeckers drill holes in **snags** (standing dead trees) or branches to use as nesting cavities. They use their strong bills to chip out the dead wood and then build a nest inside the cavity. Sometimes woodpeckers reuse these nesting cavities for more than one breeding season, and sometimes other types of birds use them. Birds in the bosque that use woodpecker cavities include nuthatches, chickadees, wrens and western screech owls. Sometimes native mice even build their nests in abandoned woodpecker holes! These trees are sometimes called "wildlife trees" due to their importance in providing animal habitats.



Cavity Nest

Additional Learning Challenge:

What will happen if large trees such as cottonwood are replaced by smaller trees such as saltcedar?

(14) Look along the river's edge for a trail that appears to have been swept with a broom going into the woods. What made this?

Beavers make trails into stands of young willows, cottonwoods or other trees. They cut small trees and drag them back to their dens in the riverbank, so the trail they leave behind looks like it was swept with a broom. Follow the trail away from the water and you may find the area where the beaver has cut small saplings. They prefer to cut young, tender trees rather than large, old ones. If they cut down large trees, they only take the smaller branches and leave the trunk. They eat the inner layer of bark, called the **cambium** (CAM-bee-um).



Beaver Trail

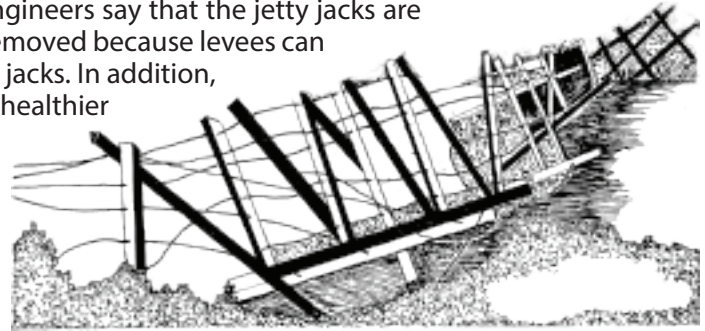
Additional Learning Challenge:

Can you identify the type of trees the beavers are cutting?

What happens if there are no young trees for the beavers to cut?

**(15) Look for big metal structures near the river.
What are these and why are they here?**

These are called Kellner jettys, jacks, or “jetty jacks.” Jetty jacks were put in along the river by the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation, starting in the early 1950s. They helped to straighten the river and protect the levees. They work by slowing the speed of the river’s flow, which causes **sediment** (dirt) carried by the water to drop out. As the dirt builds up, **riparian** (rye-PEAR-ee-an; streamside) plants can start to grow. This helps keep the river bank in one place, and prevent the river from moving across the floodplain. This also protects the levees during a flood, preventing the floodwaters from eroding the levees. Today, engineers say that the jetty jacks are no longer needed and some jetty jacks are being removed because levees can now be built to withstand floodwaters without the jacks. In addition, we also now know that floodplain ecosystems are healthier if the river can move freely across the land.



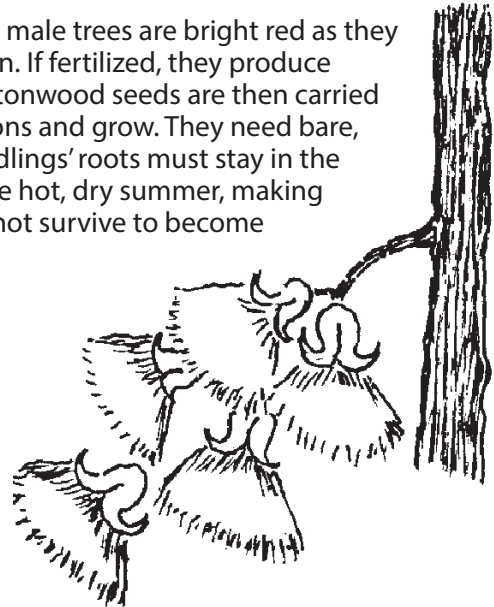
Jetty Jacks

Additional Learning Challenge:

How does straightening the river affect the plants and animals that live here?

(16) Does it look like snow in the summer? Find some cottonwood cotton and inspect it carefully. Why do cottonwoods make cotton?

Cottonwoods have separate male and female trees. The flowers on male trees are bright red as they emerge; they produce pollen. The flowers on female trees are green. If fertilized, they produce pea-like fruits that open to release hundreds of cottony seeds. Cottonwood seeds are then carried by the wind on the chance that some will land in the right conditions and grow. They need bare, wet soil to **germinate** (GERM-in-ate), with lots of sunlight. The seedlings’ roots must stay in the wet soil as the **water table** (underground water) drops through the hot, dry summer, making that underground water harder for roots to reach. Most seeds do not survive to become large cottonwood trees.



Additional Learning Challenge:

Why do cottonwoods produce so many seeds?

Cottony Seeds on Female Cottonwood

(17) Look for a low plant with thick, leathery leaves and large white flowers during summer and fall. What is this plant and what does it tell you?

This plant is yerba mansa. It grows in moist areas or in places with a high water table. The presence of this plant in the bosque tells you that the **water table** (underground water) is probably fairly high (or near the surface). Yerba mansa has been used medicinally for generations to treat many ailments. Maybe you can ask an elder about this plant.



Yerba Mansa *Anemopsis californica*

Additional Learning Challenge:

What would happen to this plant if the water table drops due to extended drought?

(18) Look for non-native trees and shrubs, such as elm, saltcedar, Russian olive, tree-of-heaven and mulberry. What do these tell you?

The presence of introduced plant species tells you that humans have altered the ecosystem. Trees and shrubs that did not occur naturally in the bosque were introduced by people for a variety of reasons, beginning in the 1800s. Although these plants were introduced with good intentions (such as to stabilize the riverbank or because they look pretty), in certain areas, introduced plants have taken over in place of native species. Introduced plants are not all bad or all good, but some are more (or less) harmful than others. Some, such as saltcedar, make it harder for native plants to grow. Others, such as mulberry with its edible fruits, provide food for native animals. Either way, these introduced plants are now part of the bosque ecosystem.



Tree-of-Heaven

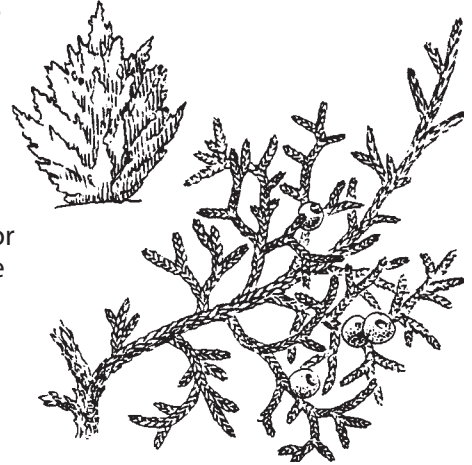
Saltcedar

Additional Learning Challenge:

How might non-native plants affect the animals that live in this area?

(19) Look for upland shrubs such as juniper, snakeweed or four-winged saltbush in the bosque. What does their presence indicate?

The presence of these upland shrubs in the bosque suggests that the **water table** (underground water) is fairly deep or that the area no longer floods, because these plants typically grow in dry soil up on the mesas. Sometimes these plants grow on the levees. Upland shrubs do well in the bosque when the ground water level drops. This is typical along regulated rivers in which dams control the flow of the river. These shrubs do not require as much water as the typical **riparian** (rye-PEAR-ee-an; streamside) shrubs like New Mexico olive or coyote willow. Juniper is a good indicator of a deep water table in the bosque, because this plant does not do well in moist soil.



Juniper

Additional Learning Challenge:

Based on the presence or absence of upland shrubs, what can you conclude about this area?

(20) Look for a cluster of bright green leaves growing on the branch of a tree that looks different from the regular leaves of that tree. What is this?

Mistletoe is a **semi-parasitic** plant that grows in cottonwoods, elms and other broadleaf trees. It can **photosynthesize** (fo-tow-SIN-thuh-size) to make its own food, but it also sends root-like structures through the tree's bark and into its branches to steal water and nutrients from its host. It is easy to see the green mistletoe plant in its host tree during the winter when the tree's own leaves have turned brown or fallen. Mistletoe is more common in southern New Mexico but has been moving north, probably because drought-stressed trees are more vulnerable. Although it can further stress the host tree, mistletoe also provides food and shelter for a large variety of animals, including birds, mammals and insects. It is very toxic to humans, though, so don't be tempted to eat its leaves or berries! The seeds of bosque mistletoes stick to the legs and bills of birds, who carry them to new trees where the seeds can grow.



Mistletoe

Additional Learning Challenge:

*Is mistletoe harmful or beneficial to the whole ecosystem? Why?
How might global warming affect the mistletoe and its host trees?*

(21) Look at a group of cottonwood trees. Are they all the same age?

Cottonwood seeds **germinate** (GERM-in-ate; sprout) on sand bars or open areas where conditions are favorable, with plenty of available light and moisture. Typically, many seeds will germinate along the same stretch of ground when conditions are good. This results in a whole group of cottonwood trees that are the same age growing up together in a patch. We call this group of same-aged trees a cohort. Although trees that are the same age are generally in the same size class with roughly the same height and diameter, sometimes their sizes can vary.



Cottonwood Cohort

Additional Learning Challenge:

What could cause trees that are the same age to be different sizes?

(22) Look along the edge of the river, along channels or on sandbars. Can you find baby cottonwoods?

Baby cottonwoods (seedlings) need bare soil where they have lots of sunlight and lots of water. The conditions needed by baby cottonwoods are less common now because flood control and other conditions have altered the river. As a result, there are very few young cottonwoods along the Rio Grande, and many young trees are washed away with each year's high water. Land managers are now changing their approach and trying to improve growing conditions to allow cottonwoods to again thrive in our bosque by allowing **overbank flooding** in high water years, creating secondary channels and planting cottonwoods.



Baby Cottonwood

Additional Learning Challenge:

What will happen to the bosque if there are no baby cottonwoods?

(23) Look for cattails, sedges or other marsh plants. What does this tell you?

It is likely that this is a wetland created by humans. Although marshes, ponds and wet meadows were once common in the floodplain, wetland habitats decreased after humans regulated the river and drained the floodplain to create farms and build cities. Now land managers know how important wetlands are. They help with flood control, improve water quality, decrease soil erosion, provide habitat for many plants and animals, and more. Land managers now create wetland habitats such as ponds and marshes. These are great places to go to look for wildlife!



Cattails

Additional Learning Challenge:

What are things that you could do to help protect and restore wetlands in New Mexico?

(24) Look at the state of individual cottonwoods. How can you tell a healthy cottonwood from an unhealthy cottonwood?

Cottonwoods usually live where water is abundant. This would be true in the **riparian** (rye-PEAR-ee-an; streamside) zone of a river in its natural condition. When cottonwoods do not get enough water, they become unhealthy. They often have dead branches with dry, brown leaves, even in summer. Some of their branches may fall off due to drought stress. In some trees you can see a dark liquid coming from where a branch fell off. These trees may be more susceptible to attacks by insects. In contrast, healthy trees have full green leaves and branches.



Healthy Cottonwood



Unhealthy Cottonwood

Additional Learning Challenge:

Do most of the cottonwoods in this area appear to be healthy or unhealthy? What might this tell us about the availability of water here?

(25) Look for cottonwood trees with a single trunk and trees with several trunks growing from the base. What causes the difference?

A cottonwood can grow from a seed, or by sprouting from an existing trunk or a shallow root. The cottonwood with a single trunk grew from a seed. The group or cluster of trunks grew from sprouts called **suckers**. Cottonwoods grow suckers in response to many types of disturbances that cut down the original tree. Examples of disturbances include being cut by a beaver, being burned by a fire, or being knocked over by a flood. Usually the underground roots are not bothered by these things, and the tree is able to sprout again. When it does, it typically sends up several stems instead of just one. This results in clusters of trees that come out of one base. Sometimes they look like separate trees because dirt has covered up the area where the trunks are joined, but you can still see that the trees are growing very close together.



Multi-trunk Tree



Single-trunk Tree

Additional Learning Challenge:

How would the ability to re-sprout be an advantage to a tree exposed to many disturbances?

(26) The bosque changes based on the seasons. What things do you notice in or near the bosque that tell you what time of year it is?

Some examples:

a) Spring—cottonwood flowers. Cottonwoods flower only in the spring, usually around April in the Middle Rio Grande Valley. The exact date varies among years, and flowers come out earlier in more southern areas. The red catkins of male flowers are easier to see than the green female flowers.

b) Late spring/early summer: cotton in the air. The cotton carries the cottonwood seeds. It is released during the period when the river is most likely to overflow its banks and create habitat for seed germination and seedling growth.

c) Fall—cottonwood leaves have turned yellow.

d) Fall or spring—V of cranes flying overhead. Large numbers of waterfowl (ducks, geese, cranes) migrate along the Rio Grande. They fly south in the fall. In the spring, they can be seen flying north.

e) Winter—flock of crows roosting in cottonwoods. Large numbers of crows roost in the bosque during the winter. In the summer, most of them head north to breed, but some stay in the valley.

f) Winter—most cottonwood leaves have fallen off the trees, or if still on the tree branches, the leaves are dry and brown.



Flowering Cottonwood



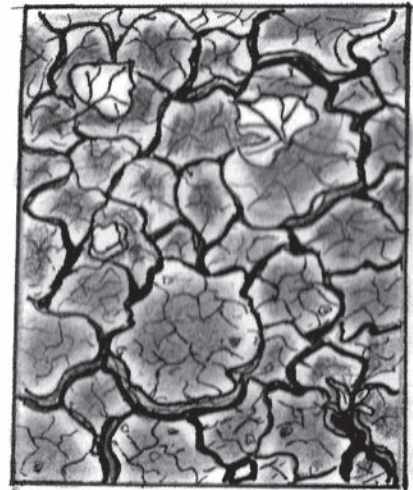
Yellow Leaf in Fall

Additional Learning Challenge:

What other examples can you see? How might climate change alter these seasonal clues?

(27) Look for cracks in the soil and rings of mud or debris (de-BREE) at the base of the trees. Why are these here?

When the snow melts high in the mountains and the streams swell with water, the river naturally swells as well. When so much water comes down the river that it can no longer stay in the channel but has to flow over the riverbanks, this is called **overbank flooding**. Today we have several reservoirs that capture and hold this spring runoff to make water available later in the summer for farming, so fewer places in the bosque experience overbank flooding naturally. Because flooding helps the forest, land managers now do allow the bosque to flood in the years in which enough water is available. One way to identify areas that flood is to look for mud rings or **debris** (de-BREE; grass, leaves, trash, etc) on the trees. The spring river water carries **sediment** (dirt) that is deposited in the forest. The height of the mud rings indicates the depth of the flood water. Soils that are wetted regularly also develop cracks when they dry out. They are called mud cracks.



Mud Cracks

Additional Learning Challenge:

What other signs of regular flooding do you see?

Do you think the area you are in has flooded in recent years?

**(28) Look for a bend of a river.
Can you tell which side of the river is moving faster?**

The river flows faster on the outside edge of a bend, or **meander** (mee-AN-dr). The swift water cuts into the outer bank, eroding away some of the soil and cutting a sharp bank on that side. On the inside of the bend, the water moves more slowly. This slower-moving water drops some of the **sediment** (dirt) it carries, along the edge of the meander. The sediment gradually builds up, pushing the inner bank out into the river to form a sandbar. This is how the course of a river moves across the landscape: by eroding and depositing sediment.



Meander

Additional Learning Challenge:

How would floodplain vegetation be affected by a moving river?



9. Winter Bud Activity

Description: Students closely observe tree and shrub buds and make detailed drawings while on a winter hike. Back in the classroom, students connect twig structures to their functions.

- Objectives:** Students will:
- develop skills of observation and recording;
 - observe and ask questions to make discoveries; and
 - learn the structures and functions of twig parts.


- Materials:**
- Field Journals or plain white paper
 - Handouts (add to Field Journals before trip): *Winter Buds - Student Guide*; *Winter Buds -- Twig Terms -- Student Reference Sheet*. For classroom, *Plant Function Analogy Challenge!*
 - Tape / glue
 - Pencils
 - Colored pencils
 - Hand lenses or magnifiers
 - Rulers

Optional preparation for classroom:

- Shears or pruner
- Large bag to hold twigs of assorted broad-leaved plants

Phenomenon: Many plants in winter just look dead, but they can grow again in spring.

- Lesson Questions:**
- *What features of winter twigs can I identify?*
 - *What analogies can I use to explain the functions of twig parts?*

9. Winter Bud Activity 

Grades: 1–12

Time: one or two class periods and field exploration

Subjects: science, art

Terms: *analogy, axillary bud, bud, bud scales, bud scale scar, bundle scar, chill hours, deciduous, gibberellin, internode, leaf scar, lenticel, node, phenology, pith, prickles, spine, terminal bud, thorn, whorled*



New Mexico STEM Ready! / Next Generation Science Standards

NGSS DCIs

NOTE: see NGSS Connections to *Going Out: Field Activities* at the end of this chapter for more possible field trip NGSS connections and for suggestions using each standard.

1.LS1.A Structure and Function

4.LS1.A Structure and Function

MS.ESS3.D Global Climate Change

NGSS CCCs

Patterns; Structure & Function

NGSS SEPs

Asking Questions & Defining Problems; Developing & Using Models

Background:

“The approach of autumn, with its showers of many-colored leaves, spells the end of the season’s activities in the identification of deciduous trees and shrubs. Without leaves the members of the forest community, unless they be relatively large, seem to lose much of their summer’s identity and may even descend to the level of ‘brush’. This is in reality not the case, as may be easily discovered by examining any leafless twig with a 10X pocket lens, or even with the naked eye. A casual glance. . . will also serve to show that woody plants in winter are anything but featureless.”

—William M. Harlow, Ph.D., 1941 (as reprinted in *Winter Guide to Central Rocky Mountain Shrubs*, 1976)

Deciduous trees and shrubs (those that lose their leaves in winter) may look dead without their leaves, but in reality, they are preparing for the growing season to come. Each type of plant is very different when examined carefully. Trees may be identified during the winter by observing the position, size, shape and texture of the buds and leaf scars on their twigs. This activity encourages students to carefully look at twigs.

Buds begin to form in the autumn when the leaves fall from the trees. **Buds** are the plants’ protection from cold and dryness for their new growth. The **bud scales**, which form a cover for this growth, are actually modified leaves. Most buds are usually covered with overlapping scales, but some **scales** are joined along the edges like the two shells of a clam.

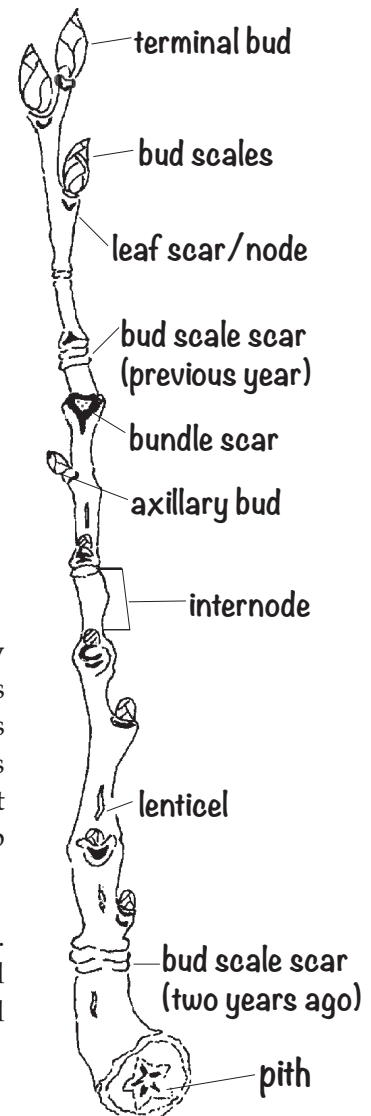
Deciduous plants must enter a period of dormancy in the winter in order to survive freezing temperatures. This dormancy prevents the plant from flowering or producing fruit during winter when it is likely that these tender tissues would be damaged. Each plant species requires a certain number of **chill hours**, with cold temperatures between 34° F and 45° F (1° C and 7° C), in order to leave dormancy and continue growing in the spring. In the seemingly dead twigs, the hormone **gibberellin** (jib-er-EL-in) that is needed for spring growth is forming. This takes place only when it is cold. To use a non-bosque tree as an example, apple trees

need 1,000 to 1,400 hours of these cold temperatures to produce gibberellin, which is necessary for the trees to flower and produce fruit. Warmer winter temperatures due to climate change are already affecting the life cycles of deciduous plants, as the required number of chill hours are no longer being met for some species. This may affect the distribution of many plant species, as well as agricultural crop production, if temperatures continue to rise.

All deciduous trees and shrubs develop new leaf buds after that year’s leaves fall off in the autumn, and also develop new flower buds after the existing flowers are spent and fall off. The leaf bud appears at the **leaf scar** where the old leaf was attached to the twig; this is also called the **node**. The buds grow slowly all winter, but in spring they develop very quickly. Look at buds any time, from after the old leaves fall off in the autumn to when the new leaves emerge in the spring. Our spring extends over many months. Siberian elms are one of the first plants to open their flowers, in January or February, while cottonwoods are 2-3 months behind them in April. Note that emergence dates may change as winter temperatures continue to rise. *How would you predict those emergence dates will change, in that case?*

See *Winter Buds – Twig Terms – Student Reference* sheet included below for definitions of terms.

If you pay attention to the cottonwoods as they wake up in spring, they do not all flower and leaf-out at the same time. We have our native Rio Grande Valley Cottonwood as well as other species of cottonwoods that have been planted here from other areas in the U.S. The transplants tend to leaf-out earlier than our native Rio Grande trees. See if you can tell where there are differences!



Here are some things to look at closely when inspecting buds:

The bud at the tip of the twig is the **terminal bud**. The **axillary (lateral) buds** on the twig may be attached with a pair of buds **opposite** each other or **alternating** along the stem. Or, several buds may be located at one position on a stem, which allows several leaves to emerge from all sides at that position; this type of arrangement is referred to as **whorled**. These characteristics can be used to help identify a plant even during the winter.

In the scar left after last year’s leaf falls, look for several small dots. These were the transportation bundles where the leaf exchanged water and nutrients with the rest of the plant; they are now called **bundle scars**.

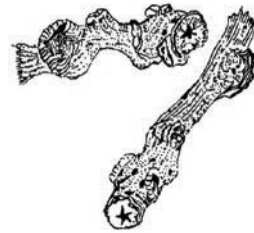


Along the stem you can often see small warty spots. Look closely. *Are they bugs?* They are **lenticels**, which are breathing pores for the cells of the inner bark that enable them to take in and release gasses from the atmosphere.

The number of years of a twig's growth can be counted by looking for rings around the twig. Each year at the terminal bud scale, the twig moves into its new growth and leaves a new circular scar, resulting in a set of small rings encircling the twig over time. You can count the number of terminal **bud scale scars** along a twig and know how many years it has grown. You can also compare different years by measuring the distance between the terminal bud scars—*did it grow more one year compared to another year? Why might that be the case?*

Does the plant have prickles, spines or thorns? Is the bark smooth, waxy, fuzzy or hairy? These characteristics may help differentiate the plant from other plants. *How do these features help the plant?*

When you break or cut the twig cross-ways, what does the center look like? In the cross-section of a cottonwood you should find a surprise: the inner **pith** (central stem tissue) is in a star shape! This is a characteristic of all trees in the genus *Populus*.



In this activity, students will carefully observe buds of different shrubs and trees while in the bosque or other outdoor setting. Students will illustrate and label one twig and make written notes describing the twig. Back in the classroom, students will write analogies about the functional connections of twigs and buds.

Procedure:

- ♣ Make a KWL chart with your students.

*What do you **Know** about buds on trees and shrubs?*

*What do you **Want** to know about buds on trees and shrubs?*

Ask students how we can find out about buds. Encourage them to think about observation as a method for answering their questions. After the lesson, revisit the chart and ask, *What have you **Learned** about buds on trees and shrubs?* (**Asking Questions & Defining Problems**)

NOTE: This activity looks at trees and/or shrubs that lose their leaves in the winter (deciduous plants). Evergreen trees and shrubs do not lose their leaves in the winter and do not have the characteristics we are highlighting here.



♣ Trip to the bosque:

- Before your trip, copy the *Winter Buds—Student Guide* and the *Winter Buds—Twig Terms—Student Reference* handouts below, trim and glue into Field Journals (or fold and glue along part of the page) for reference while doing drawings.
- In the bosque, take a “bud hike.” Observe buds on many different shrubs and trees. Feel them, smell them, observe their position, color, sheen, etc. Use magnifiers to observe closely.
- Each student should choose a bud to draw, measure and describe. In their Field Journals, have them make three columns, labeled as in the picture below, with the middle column wider than the outer two columns. Alternatively, give each student an 8.5” x 11” piece of white paper. Fold the paper into three sections like a science fair display board by having the two sides of the paper meet in the middle. Open it back up and have them put their name on the paper and add the labels as shown below. Have available magnifiers, rulers, pencils and colored pencils.
- In the center, **draw and label the twig with the buds.** Use the *Winter Buds—Student Guide* and *Winter Buds—Twig Terms—Student Reference* sheets to help identify the parts of the twigs while in the bosque. **For younger students,** you may simplify by looking only at terminal buds, bud scales, bud scale scars and leaf scar.
- On the left side of the page, students should **write down as many observations as they can about the buds and the twig.** Use descriptive adjectives.
- You will use the right side of the paper back in the classroom, so just leave that blank while in the field.

OPTIONAL PROCEDURE:

- If weather or other conditions make it impossible to make observations and do illustrations while in the bosque, you may choose to do this activity entirely in the classroom, or take a walk in the schoolyard or neighborhood to look at winter twigs and then do all of the illustrations and other observations back in the classroom.
- In this case, the teacher can cut (using pruning shears) a few short, sample twigs from different trees and shrubs, **preferably from downed branches.** A couple of different twigs for every three or four students are needed.

NAME: DATE:

My Winter Twig

Describe in Words Draw a Picture Label the Parts Analogies

FOLD/LINE FOLD/LINE



NOTE: Please limit the amount of cutting you do. There are places such as the Rio Grande Nature Center where cutting will not be allowed. We don't want to have a major impact on the vegetation in the bosque so take only a minimal amount. Look for a downed cottonwood branch with visible buds; these twigs will work well for this activity.

♣ Classroom

- Review the parts of the twigs that students labeled in their drawings, and use the *Plant Function Analogy Challenge!* handout to briefly discuss the functional connections of these parts. Depending on the level of the students, you may choose one or all of the following:

Leaf arrangements along the twig are how the plant places its leaves so that each leaf can get light. *Why is this important?*

Bud scales protect the tiny growing leaves and flowers through the winter.

Bundle scars, the dots in the leaf scar where the leaf was attached last summer, are where water and nutrients flowed to and from leaves and the rest of the plant.

Lenticels, the warty bumps along the twig, are breathing pores for the cells of the inner bark, where air is taken-in and released. Plants take in carbon dioxide from the air and give off oxygen during photosynthesis.

Prickles, spines and thorns protect the plant from being eaten, especially by larger herbivores (plant-eating animals).

- Students will now make **analogies** to the functions of the twig parts. An **analogy** is a comparison between two things; to say that something is “like” another thing in some way. *How is a plant part like some other thing they know about?* Research shows that students retain information when they think of analogies about what they are learning. Analogies help students make personal connections to the object being observed. The students should think about how the twig or bud is similar in some way to something else they know about or have seen. This also can give students practice in theorizing about the natural world and lead them to question why something looks the way it does. This format is adapted from Kerry Ruef's *The Private Eye*.
- On the right side of the paper, students **should write down analogies** about the functions of the twig parts and how different parts help the plant using the *Plant Function Analogy Challenge!* handout.
- Here is an example for a non-winter plant feature: many flowers are scented. *What is an analogy for the function of the smell of a flower?* Humans make and wear perfume to “attract” other people; to smell nice for other people to notice. A flower makes a scent to attract pollinators. Be creative! Have students draw their analogy using the correct plant term(s). **(1.LS1.A; 4.LS1.A; Structure & Function; Developing & Using Models)**



Younger Students

Focus on seasons. When it is winter and the leaves have fallen off the trees, think about, *What will happen to the tree in the spring? What will it look like?* **(Patterns)**

Older Students

- Label drawings with correct terms.
- Compare buds from different types of trees.
- Compare tree buds from different locations, such as the schoolyard or neighborhood and the bosque. *Are the plant species growing at the two locations the same or different?*
- Dissect one bud from the branch. Observe and draw. *What do you think the leaves and flowers will look like in the spring? Draw their predictions.*
- Consider the effects of climate change on the timing of plant life cycles, including the role of gibberellin. *How might increasing winter temperatures affect winter dormancy? The timing of bud and leaf emergence? Flowering and setting fruit? How might such changes in plants affect humans?* **(MS.ESS3.D)**

Assessment:

Students' bud observation sheet/drawing can be used as an assessment.

After the lesson, revisit the KWL chart and ask, *What have you **Learned** about buds on trees and shrubs? Do the students show an understanding of the function of the different structures of the winter twig?*

Extensions:

- Begin this activity in the fall and repeat during the late winter and spring. If a trip to the bosque is impossible, observe tree buds on the school grounds or have someone bring in sample buds from the bosque. Have the students make a bud book to take on their bud-observing trips through the school year—looking for differences as the season changes. (Materials for bud books are white copy paper, cardboard for covers, stapler, colored pencils, or use Field Journals.) Or make a class bud book including all the types of plants observed on a single trip.
- Record the date that each kind of plant emerges with flowers and leaves; seasonal changes like these are called **phenology**. Join the BudBurst project, a community science data collection website from the Chicago Botanic Garden. Students are helping scientists understand the effects of climate change across the country by contributing their own observations to this project.
- In the spring, short branches can be cut, brought into a warm room and placed in a vase of water to force the buds to open earlier than they would outside. With this activity, students can observe the flowers or leaves emerging and see the shape of the plants' leaves. Have the students predict which buds will become flowers and which buds will become leaves, and justify their predictions.



- Write poems about the buds and twigs using the adjectives in their descriptions.
- After the trees have leafed out, students could tape the leaves or do leaf rubbings from the plants they studied into their Field Journals or observation sheets.
- Tree silhouettes: Observe the shapes of trees and shrubs during the seasons. Sketch or photograph.
- Observe leaf cells with a microscope.
- Investigate the differences in the structure of flowers that use wind vs. insect pollination.
- Investigate trees like the cottonwood that have male flowers and female flowers on separate trees (from Greek/Latin **dioecious** = “two houses” [dai-EE-shuhs]).
- Research plant hormones. *How are plant hormones formed and how do they affect plant functions?*
- Investigate the effect of pruning on branch growth.
- Compare results from year to year with your students.

References:

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- McKean, William T. 1976. *Winter Guide to Central Rocky Mountain Shrubs*. State of Colorado Department of Natural Resources / Division of Wildlife, Denver, CO.
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Winter Buds—Student Worksheet

Make a table in your journal with three columns to look like this picture. In the center column, draw your twig. Find the features listed below and add to your drawing. Label the features.

In the left column, use words to describe your twig. Save the right column for use back in the classroom. Terms in **bold** are listed on Twig Terms Student Reference page.

- Draw and describe the surface of your twig. Does it have a special color or textured covering? (smooth, waxy, fuzzy or hairy) Are there prickles, spines or thorns?
- Look closely at the bud at the tip of the twig, the **terminal bud**. Draw and/or describe it.
- What is the arrangement of **leaf scars** along the twig? (opposite, alternate or **whorled**)
- Draw the **bundle scars**—the scars you can see where last year's leaf fell off (use a magnifier!)
- Find and examine any warty bumps (**lenticels**) along the twig. Add those to your drawing.
- Look for rings that circle the twig; each ring is a **bud scale scar**. The distance between bud scale scars indicates the length of one year's growth. Count and record the number of years of growth of your twig.
- Draw any pointy parts on your twig. Identify them. (**prickles, spines, thorns**)
- Break the twig at a **node** or cut the twig crossways. Describe any color or shape of the **pith** inside.

Plant Function Analogy Challenge!

Use the right column for analogies.

How is a plant part like some other thing you know about? This is an analogy. An **analogy** (a-NAL-oh-gee) is a comparison between two things; to say that something is “like” another thing in some way. Make analogies to the functions of the following twig parts.

Leaf arrangements along the twig are ways in which leaves grow in order to get light to each leaf.

Bud scales protect the tiny growing leaves and flowers through the winter.

Bundle scars, the dots in the leaf scar where the leaf was attached last summer, are where water and nutrients flow to and from leaves and the rest of the plant.

Lenticels, the warty bumps along the twig, are breathing pores for the cells of the inner bark, where air is taken-in and released. Plants take in carbon dioxide from the air and give off oxygen during photosynthesis.

Prickles, spines and thorns protect the plant from being eaten, especially by larger herbivores (plant-eating animals).

Winter Buds--Twig Terms--Student Reference

General

Buds are the place on a plant where a leaf, flower, or stem shoot will grow.

deciduous: (dee-SID-you-us): a plant that sheds all of its leaves in one season

Bud features

bud: the encased, developing leaf or flower. They are just above the leaf scar of one of last year's leaves.

bud scales: modified leaves that cover and protect terminal and axillary (lateral) buds and flower buds; they drop off in spring when the leaves or flowers emerge.

Bud arrangement

terminal bud (also called an apical bud [APE-i ck-al]): the bud at the end of a twig. These begin to form in the fall when the leaves drop off, but continue to change even through the cold of winter.

axillary bud (AX-ill-air-ee) (also called a *lateral bud*): the buds growing on the side of the twig. The arrangement of axillary buds (and eventually the leaves) can be:

- opposite*-a pair of buds at the same point or node
- alternate*-one bud at a time a long the twig, usually spiraling along it
- whorled* (pronounced like "whirled," but with "or" in place of "i" sound)-several leaves will emerge from all sides at one node.

After buds & leaves drop

bud scale scar: (skaar): place where a previous terminal bud leaves a ring around the stem showing the beginning of a year's growth. You can count the number of bud scale scars (rings) along your stem to find how many years of growth this stem has had.

leaf scar: where last year's leaf was attached to the twig

bundle scar: spot in the leaf scar where the exchange of water and nutrients between the leaf and the rest of the plant occurred

Twig features

lenticels: (LENT-i-sells): breathing pores for the cells of the inner bark, where gases (carbon dioxide and oxygen) are taken in and released

node: the place on a stem where one or more buds, leaves or branches originate

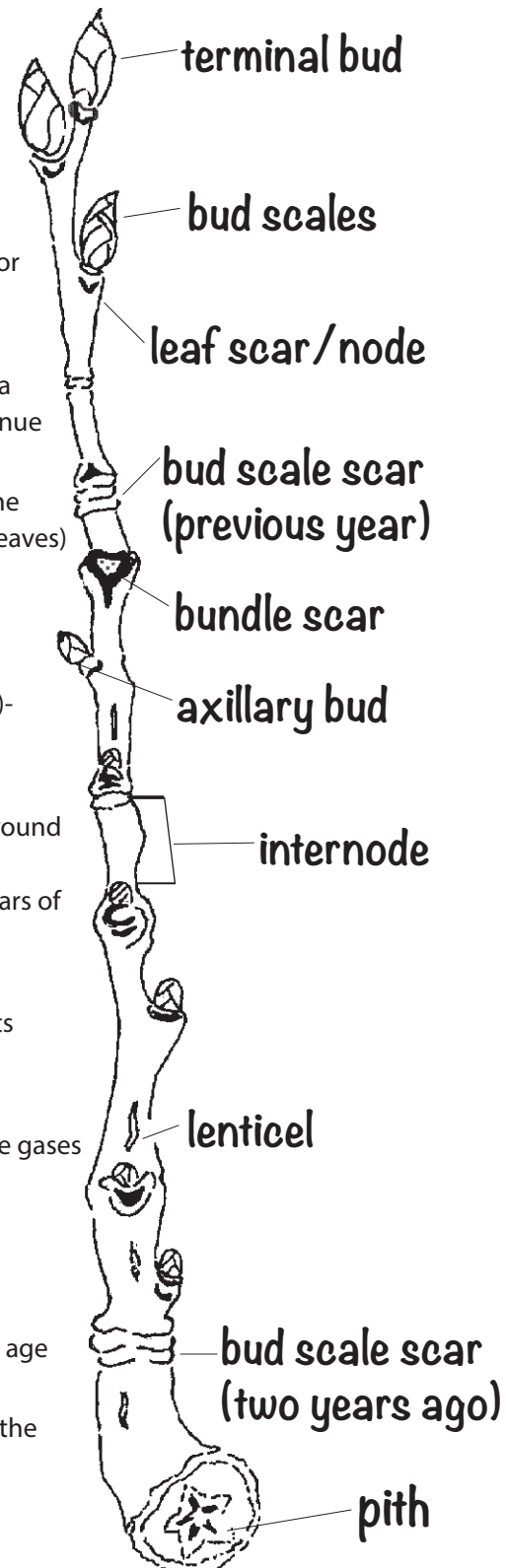
internode: the area and distance between two nodes of the stem

pith: the soft, spongy cells in the middle of the twig; they may darken with age and have a distinct shape in cross-section

prickles: (pronounced like "pickles" with a "pr"): are sharp outgrowths from the bark or skin

spines: are modified leaf parts, hard and pointed

thorns: are modified stems, hard and pointed





New Mexico STEM Ready! /Next Generation Science Standards

NGSS Connections to Going Out: Field Activities

Disciplinary Core Ideas (DCIs) and New Mexico State Performance Expectations

The following NGSS connections may be used while out on field trips, or back in the classroom following an outing, depending on specific observations and which opportunities arise. DCI's included with all of the Going Out activities are included here.

K-2.ETS1.B Developing Possible Solutions *Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.*

How can we help the bosque, including the cottonwoods and the animals that live there?

As a culminating activity, challenge students to think about what they would do in 20 years to help the bosque of the future. Allow for creative ways to show their ideas—build models, draw, video, etc.

K.LS1.C Organization for Matter and Energy Flow in Organisms *All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.*

Select some plants and animals from your discovery walk. *How does each plant or animal get the energy it needs to survive?* Plants need sunlight, air and water to survive—they make their own food with just these things.

Animals need to eat to survive. *What kinds of foods do specific animals eat?* They might eat plants, or they might eat other animals.

K.ESS2.D Weather and Climate *Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.*

Have students record the weather in their field journals each day they go out. As the year goes on, challenge them to show how things have changed through writing or drawings. Chart the temperature changes.

K.ESS2.E Biogeology *Plants and animals can change their environment.*

Look for examples of plants changing their environment. *For example, do plants that live next to the river have any effect on where the river flows? What happens to the bank of the river? On a sandbar?*

Trees and other vegetation growing along the river can stabilize the bank, affecting whether the river stays in one place or moves across the floodplain. Plants that grow on sandbars trap sediment and further stabilize the bar.

Look for examples of animals changing the environment. For example, ants create mounds and move tiny rocks and other material out of their underground nests. Pocket gophers and squirrels dig burrows, excavating soil from underground. Beavers cut trees, and in some areas (but not the Rio Grande), may build dams that create ponds. Birds build nests that may be used by other animals, including woodpeckers who excavate cavities in dead trees.

What are ways that humans change the environment?

K.ESS3.A Natural Resources *Living things need water, air and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.*

Think of the plants and animals you saw on your walk. *What resources does each need to survive, and where do they get those resources?* For example, trees need sunlight, air and water to live. They must live where those resources are available. Trees use sunlight to make their own food. If there is more water, many kinds of trees will be able to get bigger. Some types of plants require more water, so they must live in wetter areas.

Ducks need water to find their food and for protection from danger. They eat aquatic plants and invertebrates, so they need to live near ponds, ditches or the river.

Compare these to resources that humans use. *Where do we get our resources? How does that affect where we can live?*

K.ESS3.C Human Impacts on Earth Systems *Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things.*

Challenge students to think about what they might do to help the bosque of the future.

1.LS1.A Structure and Function *All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow.*

All living organisms have external structures that help them to survive. Think about plants and animals you saw on your walk. *What features do they have that help them survive?* Birds have wings to fly, fish have fins to swim, trees have leaves to absorb sunlight energy and roots to gather water and nutrients. Winter Buds: Plant structures can be observed in winter, even when the shrubs and trees have no leaves. Observe winter twigs carefully to identify plant structures; *how do these benefit the plant?*

1.LS1.B Growth and Development of Organisms *Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring survive.*

Follow up on the Parents & Young prompt and Reading the Bosque cards for nests and nesting cavities. Consider examples of parents and young seen during your walk. *In what ways (traits of plants, behaviors of animals) did you see parent organisms helping their young survive? Are eggs carefully placed somewhere? Are millions of seeds produced so that a few may survive? Is a burrow dug or a nest built to protect the growing young?* Examples include a songbird feeding its young, baby ducks guided by their mother, a spider creating an egg sack to protect its eggs, or young Sandhill Cranes staying with their parents through their first winter. Learn more about the ways parents help their offspring survive.



1.LS1.D Information Processing *Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs.*

Note animals observed during your walk and consider ways they process information. An easily seen example is ants and the use of their antennae to follow a scent trail left by other ants from their colony to mark the location of a food source. Some types of plants, such as sunflowers, actually turn their flowers to track the movement of the sun. Think of bosque animals and what body parts and senses help them to find food and escape danger. Three examples: cottontail ears/hearing, coyote nose/smell, dragonfly eyes/sight.

1.LS3.A Inheritance of Traits *Young animals are very much, but not exactly, like their parents. Plants are also very much, but not exactly, like their parents.*

How are adult organisms like their offspring? Compare baby cottonwoods (seedlings) with adult cottonwoods – how are they alike or different? Young cottonwoods have smooth bark on their stems, while adults have rough bark, but the leaves of the two ages are similar. Young insects might be quite similar to their parents (such as grasshoppers, though baby grasshoppers do not have wings) or quite different (such as caterpillars of butterflies or moths).

1.LS3.B Variation of Traits *Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.*

Students can gather cottonwood leaves from the ground. Look at them closely. *Are they all the same? Play the game where everyone gets one leaf; spend time paying close attention to your leaf—are there any individual markings or pattern in the leaf? Put all leaves in a pile. Students sit in a circle while the teacher pulls out one leaf at a time and sends it around the circle. Can each student find “their” leaf?*

Discuss how seemingly identical leaves are actually different. *How are the students able to tell them apart? In some cases it is the variation in the inherited information as the leaf grew; in others it might be an insect that chewed it, or more or less water affecting its growth.*

2.LS2.A Interdependent Relationships in Ecosystems *Plants depend on water and light to grow. Plants depend on animals for pollination or to move their seeds around.*

Look closely at plants on your walks. *What conditions are needed for plants to grow? How do we get big trees in the bosque, but not up on a mesa? Do you see flowers? Can you find pollinators visiting those flowers? Look at seeds. Plants have different strategies for dispersing their seeds—see how many different types of seeds you can find, and how they might be dispersed.*

2.LS4.D Biodiversity and Humans *There are many different kinds of living things in any area, and they exist in different places on land and water.*

Record animals or plants seen in different habitats. Each habitat has animals and plants that live well under those conditions and with those resources. *How do habitats differ, and how does that affect the plants and animals living there?*

3-5.ETS1.B Developing Possible Solutions *Research on a problem should be carried out before beginning a design solution. Testing a solution involves investigating how well it performs under a range of likely conditions. At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.*

How can we help the bosque, including the cottonwoods and the animals that live there?

As a culminating activity, challenge students to think about what they would do in 20 years to help the bosque of the future. Allow for creative ways to show their ideas—build models, draw, video, etc.

3.LS1.B Growth and Development of Organisms *Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.*

Record observations of plants on your walks in your journals. Look for seasonal changes of plants through the year: when do first leaves appear, flowers, seeds, and fall color changes. Model the life cycle of one of the plants you have been observing. Note the production of seeds and cotton by cottonwoods and the challenges the plants face in reproducing.

3.LS2.C Ecosystem Dynamics, Functioning, and Resilience *When the environment changes in ways that affect a place’s physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.*

When looking at specific animals, whether vertebrates or invertebrates (such as arthropods), consider specific habitat requirements for that species. *What would happen to that species if that habitat, or microhabitat, were to change? What if it got hotter, drier, certain food plants died out, a fire burned through the area, etc.?* Consider a variety of possible changes and how the species is likely to cope with each.

3.LS2.D Social Interactions and Group Behavior *Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size.*

Ants are easily seen examples of group-living animals in the bosque. Geese and cranes provide additional examples. *How do these organisms benefit from living in a group?*

3.LS3.B Variation of Traits

-Different organisms vary in how they look and function because they have different inherited information.

-The environment also affects the traits that an organism develops.

See 1.LS3.B for the cottonwood leaf game, to consider individual variation.

The same type of plant may differ in appearance depending on local conditions. *Is there more rainfall for one, more shade, different soil, etc.?* Animals also show variation in appearance based on variation in their local environment,



such as diet, humidity and light cycles. For example, the sex of some reptiles, including most turtles, actually depends on the temperature at which the eggs are incubated.

3.LS4.C Adaptation *For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.*

Think of plants or animals that live in the bosque or river and that you saw on your walk. *What is one species that survives well in the bosque? Why does it survive well there? What part of the bosque habitat provides what the species needs? What characteristics does the animal or plant have that allows it to live in the bosque?* An example is a woodpecker. Woodpeckers require large trees in which they can drill nesting holes. The cottonwoods provide this habitat. The woodpecker has a stout bill, a stiff tail used for balance and a special toe arrangement that allow it to climb up tree trunks and drill holes. Contrast the bosque habitat with other habitats in North America that have different conditions, perhaps less water or harsher winters. *What is an example of an organism that lives well in a different habitat, but would not do well in the bosque? What signs did you find that tell us something about the animals that live in that particular habitat? Consider also microhabitats within the bosque. What kinds of organisms survive well, less well or not at all in that particular microhabitat?*

3.LS4.D Biodiversity and Humans *Populations live in a variety of habitats, and change in those habitats affects the organisms living there.*

Record animals or plants seen in different habitats or microhabitats. Consider also signs that tell us something about what habitat an animal uses. Each habitat has animals and plants that live well under those conditions and with those resources. *How do habitats/microhabitats differ, and how does that affect the plants and animals living there? What will happen to the plants and animals if the habitat/microhabitat changes?*

4.LS1.A Structure and Function *Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.*

All living organisms have internal and external structures that help them to survive. Use plants and animals you saw on your walk. *What characteristics do they have that help them survive, and what is the specific function of each structure?* Birds have wings that allow them to fly, fish have fins that help them swim, porcupines have long claws to help them climb trees, trees have leaves to absorb sunlight energy and roots to gather water and nutrients. Internal structures include hollow bones in birds to reduce weight and help them fly, a jaw that can dislocate to allow a snake to eat large prey or special vascular tissues in trees (xylem and phloem) that transport water, sugars and other materials around in the plant. Each particular structure provides a function that helps that animal or plant to live successfully.

Pick any plant or animal. What structures enable it to survive? Write about it or make a model with labeled features. Use evidence, data and/or a model to explain your reasoning.

Winter Buds: Plant structures can be observed in winter, even when the shrubs and trees have no leaves.

Consider structures that help plants survive in winter, as well as the function of structures easily observed at that time.

4.LS1.D Information Processing *Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.*

Note animals observed during your walk and consider ways they process information. An easily seen example is ants and the use of their antennae to follow a scent trail left by other ants from their colony to mark the location of a food source. Another example is bird communication. Birds use auditory communications; one bird sings or chirps while another hears the song. Songs provide information about territory boundaries as well as mate choice. Chips and chirps are used to keep contact with other flock members. Other types of sounds, like drilling on tree trunks, are used as well. Birds are able to process and understand these auditory signals.

5.LS1.C Organization for Matter & Energy Flow in Organisms *Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. Plants acquire their material for growth chiefly from air and water.*

Plants need sunlight, air and water to survive—they make their own food with just these things. Animals need to eat to survive. They might eat plants, or they might eat other animals. Use **Species of Greatest Conservation Need** as examples. These are animals that are threatened or endangered, or considered at risk of becoming so, and so need extra management attention. How does each species get the materials and energy it needs to survive? **Rio Grande Silvery Minnows** eat algae and tiny plant pieces found in the river. **New Mexico Meadow Jumping Mice** live in marshes where they eat flowers and seeds of grasses and other plants, in addition to insects. **Northern Leopard Frogs** eat insects that fly near water; they must feed in wet habitats. **Southwestern Willow Flycatchers** also eat insects that fly near water and so live in riparian vegetation. **Bald Eagles** eat fish, or carrion (dead animals), so they typically live and hunt near water courses. All of these animals need wetland habitats to acquire the materials and energy needed for body repair, growth and motion.

Consider various animals that eat cambium, the inner bark of trees (beaver, porcupine, bark beetles). *How do each of these obtain the food they need to survive?*

5.LS2.A Interdependent Relationships in Ecosystems *The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plant parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.*



Consider organisms that you see on your walk, and categorize them as producers, consumers, decomposers (or nonliving). *How might the different organisms be related?*

Look for lacy cottonwood leaves, signs that decomposers have been at work. How did the leaf get to be lacy? What organisms depend on cottonwood leaves?

Have any introduced species damaged this ecosystem? (See the Guide for more information on introduced species!)

5.ESS3.C Human Impacts on Earth Systems *Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.*

From your walk in the bosque, think about the signs of humans changing things in the bosque. There are great things and maybe not so great things. *Can you make some lists? What are ways that humans are helping the river and the bosque? What restoration projects did we see on our walk? Are any animals or plants helped by these restoration projects? If so, which animals or plants are helped, and in what ways are they helped through those projects? When sampling aquatic invertebrates, what does the composition of the species present tell us about the quality of the habitat? How do humans affect the species present in an aquatic ecosystem? How might the actions of humans increase the risk of fire in the bosque, both directly and indirectly, and how can we decrease that risk?*

MS.LS2.A Interdependent Relationships in Ecosystems

- *Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.*

- *In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.*

- *Growth of organisms and population increases are limited by access to resources.*

- *Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions can vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.*

Mistletoe is a partial parasite that depends on its host cottonwood trees. How does it survive and reproduce?

MS.LS2.C Ecosystem Dynamics, Functioning and Resilience

- *Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.*

- *Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.*

On your walk, look for the diversity of living organisms. Try to get a sense of the biodiversity of the bosque. Make lists of plants and animals or animal sign observed.

How might the species present change with changes to the physical or biological components of the ecosystem? For example, if the climate continues to warm and drought continues in New Mexico, how might microhabitats within the bosque change, and how might that affect species living there? How has the local biodiversity already been affected, such as with the introduction of non-native plants or the presence of upland plants in riparian areas? How have human actions, such as the introduction of jetty jacks and changes in river flow, affected the species present?

MS.LS4.D Biodiversity and Humans *Changes in biodiversity can influence human's resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.*

How do the human-caused changes to bosque habitats affect the organisms living there? What value can people put on the bosque? What benefit does the bosque give to humans? (Monetary, spiritual, ecological, mental, etc.?)

MS.ESS3.D Global Climate Change *Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding human behavior and applying that knowledge wisely in decisions and activities.*

Winter Buds: Many plants depend on cold winter temperatures to facilitate certain aspects of their annual cycles, such as the development and timing of bud and leaf emergence, flowering and setting fruit. *How might global warming affect these aspects of plant life cycles, how would such changes affect humans, and what might we do to lessen these impacts?*

HS.LS2.C Ecosystem Dynamics, Functioning, & Resilience

- *A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.*

- *Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.*

When sampling aquatic invertebrates, what does the composition of the species present tell us about the quality of the habitat? How do humans affect the species present in an aquatic ecosystem? How might changes in the composition of species present affect the ecosystem overall? How might species composition affect the resilience of the ecosystem?



New Mexico Specific Science Standards



Because these performance expectations are unique to New Mexico, we present the PEs as well as the supporting DCIs, CCCs, and SEPs that can be addressed by the Signs of Humans activity.

New Mexico Performance Expectation

MS.Human Impacts

MS-ESS3-3 NM Describe the advantages and disadvantages associated with technologies related to local industries and energy production. [Clarification: Examples may include examining short- and long-term impacts of related technologies on water usage (such as the withdrawal of water from streams and aquifers, the construction of dams and levees, or sewage treatment plants), land usage (such as urban development, agriculture, the removal of wetlands, or solar panel installation), pollution (such as of the air, water, or land), local employment, and economic stimulus.]

MS.ESS3.C Human Impacts on Earth Systems

-Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.

-Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

-The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

From your walk in the bosque, think about the signs of humans changing things in the bosque. There are great things and maybe not so great things. *Can you make some lists? In what ways have humans altered the bosque? What organisms may be affected by these changes? How might impacts on resources be increased as human consumption increases?*

What are ways that humans are helping to manage the river and the bosque? What restoration projects did we see on our walk? Are any animals or plants helped by these restoration projects? If so, which animals or plants are helped, and in what ways are they helped through those projects? How do humans benefit from these management practices? How might the actions of humans increase the risk of fire in the bosque, both directly and indirectly, and how can we decrease that risk?

MS.ETS2.B Influence of Engineering, Technology, and Science on Society and the Natural World

The uses of technologies and any limitations on their use are driven by individual or societal needs, desires and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

After years of building structures in the Rio Grande and its floodplain with the goals of reducing flooding, drying out waterlogged soils and delivering water for irrigation, biologists began to see impacts on the bosque ecosystem that were not intended or expected. The cottonwood forest corridor of the river was getting old, with few seedlings growing to replace them. Fish species like the Rio Grande silvery minnow were not finding the shallow, muddy, backwater areas needed to lay their eggs and produce successful fry. Have students research one of the species listed below to understand why their numbers have been reduced, and then how managers can improve conditions for their eventual success. Some of these may include engineering projects.

Species of Greatest Conservation Need (SGCN):

Rio Grande Silvery Minnow (*Hybognathus amarus*)

Northern Leopard Frog (*Lithobates pipiens*)

Bald Eagle (*Haliaeetus leucocephalus*)

Yellow-billed Cuckoo (*Coccyzus americanus*)

Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

New Mexico Meadow Jumping Mouse (*Zapus luteus*)

San Juan River SGCN Species:

Colorado Pikeminnow (*Ptychocheilus lucius*)

Razorback Sucker (*Xyrauchen texanus*)

CCCs: Cause and Effect; Systems and System Models

SEPs: Engaging in argument from evidence; Obtaining, Evaluating and Communicating Information

Activity: *Signs of Humans*

Additional Standards:

Science, Technology, Society, and the Environment Interdependence of Science, Engineering & Technology

K-2 Science and engineering involve the use of tools to observe and measure things.

3-5 Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies.

Use simple tools as you explore the bosque, such as thermometer, ruler, compass and magnifiers, to help observe and measure things.

Crosscutting Concepts (CCCs) (See Appendix K for descriptions)



Patterns

Cause & Effect

Systems & System Models

Structure & Function

Stability & Change

Science and Engineering Practices (SEPs) (See Appendix K for descriptions)

Asking Questions & Defining Problems

Developing & Using Models

Planning & Carrying Out Investigations

Analyzing & Interpreting Data

Constructing Explanations & Designing Solutions

Engaging in Argument from Evidence

Common Core Connections

English Language Arts:

Text Types & Purposes

Production & Distribution of Writing

Research to Build and Present Knowledge

Reading Informational Texts*

Vocabulary Acquisition and Use*

Mathematics:

5.MD Measurement & Data

Represent & Interpret Data

Statistics & Probability

Activity: Naturalist Notebooks

Geography:

Geographic Representations & Reasoning



*Young Rock Squirrels (Otospermophilus variegatus)
at Rio Grande Nature Center State Park*

Photograph by Laurel Ladwig

