19. *The Web*

Interactions in the Bosque Ecosystem

Description: Students choose a plant or animal in the bosque; then, while standing in a circle, they show connections with other plants or animals by passing a string from one organism to another, illustrating relationships in the web of life.

Objective: Students will learn that:

- there are many species that depend on each other in the bosque ecosystem; and
- that the loss of one will affect other species.

Materials:

- Large ball of string
- Bosque animal cards from #15 "Who Lives Where?" activity
- Bosque plant cards from #16 "Who Grows Where?" activity
- Decomposition card from #46 "Energy in a Bosque Ecosystem" activity (optional)

Phenomena: Porcupines are seen high in trees. Birds build nests in bosque trees and bushes. Harvester ants carry seeds. Mosquitoes are annoying but other animals eat them.

Lesson Question:

- *How do plants and animals need each other in the bosque?*

19. The Web

Grades: 3-8

Time: one hour

Subject: science, extensions in language, writing, drawing

Terms: *abiotic, biotic, carnivore, ecosystem, food chain, food web, herbivore, mutually beneficial, omnivore, photosynthesis, Species of Greatest Conservation Need (SGCN), threatened/endangered species, web of life*
[Most are in the Glossary - three others are defined in context below]

New Mexico STEM Ready! / Next Generation Science Standards

NGSS DCIs

3.LS2.C Ecosystem Dynamics, Functioning & Resilience
3.LS4.D Biodiversity & Humans
5.LS2.A Interdependent Relationships in Ecosystems
5.ESS3.C Human Impacts on Earth Systems
MS.LS2.A Interdependent Relationships in Ecosystems
MS.LS2.B Cycles of Matter & Energy Transfer in Ecosystems
MS.LS2.C Ecosystem Dynamics, Functioning & Resilience
MS.LS4.D Biodiversity & Humans*
MS.ESS3.C Human Impacts on Earth Systems*

NGSS CCCs

Patterns; Cause & Effect: Mechanism & Explanation; Systems & System Models; Energy & Matter: Flows, Cycles & Conservation; Stability & Change

NGSS SEPs

Asking Questions & Defining Problems; Developing & Using Models; Engaging in Argument from Evidence*; Obtaining, Evaluating & Communicating Information
(* indicates extension activity)

Background:

Energy from the Sun provides the fuel for most life on the planet. Plants are able to use the sun's energy, through **photosynthesis**, to make their own food. With carbon dioxide and water and the energy provided by the sun, plants make glucose/sugars that provide the energy for growing leaves, stems, flowers, and fruit. Some animals will eat plants to get the nutrition/sugars they need to grow, move, and reproduce (**herbivores**); in turn, other animals will get their nutrition/sugars from eating other animals (**carnivores**); and still others will eat a combination of plants and animals (**omnivores**). Strictly speaking, a "food web" does not include the Sun. Organisms cannot eat the sunlight, so it is not "food"; **sunlight** is the **energy** that allows a plant to make food for itself. A **food chain** indicates the connections between organisms showing what eats what. A **food web** will include multiple species eating another species, and being eaten by many species (i.e., multiple food chains). But in this activity, we are trying to get students to think about any connection between organisms, not only food-related ones. Animals live in **habitats** where they must have **food**, **water**, **shelter**, and the **space** needed to survive. We refer to all such interactions, not just the food chains, as the **web of life**. For example, birds need to perch on things and make nests of material that they don't eat, but without those parts of the habitat, they cannot survive. Some species of mistletoe depend on a bird to eat its berries, fly to another tree, and deposit its seeds there. (This activity focuses on the **biotic** or living components of the system. The **abiotic** or nonliving parts—air, water, soil, temperature, shade, etc.—although also very important, are not a focus of this activity.) Students will model the interactions between organisms in a bosque **ecosystem**. They should think of as many connections as they can between the plants and animals in the bosque when they do this activity. They will begin to see the links among components in the complex web of life.

Procedure:

- Make a KWL chart with your students.

  *What do you **Know** about how living things are connected in the bosque?*

  *What do you **Want** to know about how living things are connected in the bosque?*

  *After the lesson, revisit the chart and ask, What have you **Learned** about how living things are connected in the bosque?* **(Asking Questions & Defining Problems)**

  - *Where do plants and animals get the food they need to survive and grow? What does each species need to survive (i.e., the food, water, shelter, space in the bosque)?* **(Systems & System Models;** see Appendix K**)**

  An informal assessment, as you start the activity, is to have students design a food chain or a food web based on what they know now:

  - *What is the "Web of Life?"* Think of yourself as some living plant or animal. *What do you need to live as that plant or animal; what food, water, shelter, and space do you need?*
  - Now consider two organisms such as coyote and yerba mansa. *How might they be connected in the bosque web of life?*

  To best do this activity, it helps for your students to be familiar with some plants and animals of the bosque. Some options:

  - Do a walk in the bosque or schoolyard with your students. *What plants and animals do you see? What signs of animals do you find? What are the habitat needs of each plant or animal they have seen? What food does each animal eat?*
  - Make a class list to summarize all observations.
  - Think of food chains and/or food webs from the plants and animals they have seen.
  - Find an online video to introduce your students to the bosque, and, as a class, think of food chains and/or food webs from some of the species they see on the video.
  - Find a video about food chains and food webs in general.
  - Do the River of Change activities #13 "Changing River" and #15 "Who Lives Where?"

  Select an assortment of bosque plant and animal cards so that there is one for each student. Use the pictures of animals from #15 "Who Lives Where?" activity and at least the cottonwood picture from #16 "Who Grows Where"; all are in this *Guide*. Include an insect, such as the mosquito. Use the Decomposition card from #46 "Energy in a Bosque Ecosystem" activity to address interdependence, how the loss of one species affects the other species, as part of a second round. **(5.LS2.A)**

- Pass out the plant and animal cards. Have all the students stand in a circle and state what plant or animal they are. Then challenge them to make connections between themselves and another plant or animal.

The discussion might go as follows:

All the energy for plants and animals on the Earth comes from what? (the Sun)

What organisms on Earth make use of that energy directly? (plants)

What is the process that plants use to do that? (photosynthesis)

So, let's start with a plant. (Give one end of the string to a plant.)

What eats the plant? (Send the string to an herbivore.)

What eats an herbivore? (Send the string to a carnivore.)

What does each animal consume? What eats it? How are the animal species' needs met in the bosque ecosystem?

Now let's make as many connections as we can think of between species. We want to get beyond just what eats what.

- *Where will its home be?*
- *Does it need a place to perch to find food?*
- *Does it need the droppings of something to fertilize it?*
- *Are any species competing with each other?*
- Add non-living factors to achieve more of this standard (see *Extensions*).
- *What happens when species are competing for food, water, oxygen, or other resources?* For example, many species eat seeds on the ground. Some kinds of insects are competing with birds such as the Spotted Towhee or Dark-eyed Junco for seeds on the ground.
- *What role do predators play in this ecosystem?*

Be creative in thinking of connections. **(5.LS2.A; MS.LS2.A; Energy & Matter: Flows, Cycles & Conservation)**

Pass the string between all the organisms that are connected. Make sure everyone is included. You will have created quite a web!

Continue the activity by asking:

- *What happens when we lose a piece (i.e., one of the organisms in an ecosystem)?*
- *How about the* ***mosquito****?*
    - I don't like mosquitoes. I would prefer not to be bitten by any more mosquitoes, so I am going to spray pesticides to get rid of them.
    - Mosquito, you shake your string(s) to show that something is happening to you.
    - *Who feels the shaking?* You have been affected by the loss of the mosquito.
    - Now everyone who feels the shaking, shake your strings to pass it on. In this way, the loss of one species is felt by many others; one change in an ecosystem ripples throughout.

In real life, there are many connections between organisms, some of which researchers are just now learning about. Sometimes we find out about the crucial role of a species only when it is too late to do anything to save it.

There are **threatened** and **endangered** species, and **Species of Greatest Conservation Need (SGCN)** so designated by New Mexico Department of Game and Fish, that eat mosquitoes (either mosquito larvae or adult mosquitoes). The **Southwestern Willow Flycatcher** is one of them. They perch on branches in thick stands of willow or cottonwoods and eat flying insects. In the San Juan River, **Razorback Suckers** eat the larvae of aquatic insects like mosquitoes. Adult **Northern Leopard Frogs** will catch flying insects like mosquitoes.

Return to the question,

What happens when we lose one of the organisms in an ecosystem? **(3.LS2.C; 3.LS4.D; 5.LS2.A; MS.LS2.A; MS.LS2.C; Cause & Effect: Mechanism & Explanation; Stability & Change)**

Here is an example of two species needing each other: In New Mexico, the state flower is the **yucca**. There is only one kind of insect that can pollinate the yucca flower; the **yucca moth**. Other insects may visit the flowers of a yucca, but only the yucca moth has the ability to pollinate them. If something were to happen to yucca moths and no more were alive, we would not have any more yucca plant seeds, and once the old yuccas die off, we would have no more yuccas. The yucca fruits are eaten by people and animals. Birds nest within the spiny leaves. Pueblo people have used this plant for generations to make string and rope for sandals, nets to catch food, and a soap from its roots. So, without one kind of insect, one kind of plant would be lost. The loss of that plant would affect many, many other organisms. It is for these reasons that we talk about threatened and endangered species. The yucca plant is a great example of a **mutually beneficial** interaction becoming so interdependent that the yucca depends on the yucca moth for survival. Neither would be able to survive without the other.

*Can you think of other **mutually beneficial** interactions among plants and animals? In what specific ways might plants and animals depend on each other? What happens if one partner in this mutually beneficial relationship is lost?* **(3.LS2.C; 3.LS4.D; MS.LS2.A; MS.LS2.C; Patterns; Cause & Effect: Mechanism & Explanation)**

Here is an example of a different type of habitat need: Along the Rio Grande, the large cottonwood trees sometimes have holes where a branch has died or a woodpecker has excavated a **nest cavity**. These cavities are used by many other birds for their nests. Woodpeckers can make their own holes, but other birds must find a hole already prepared. **Starlings**, birds introduced to America from Europe, have moved into the bosque and are very aggressive about claiming holes for nesting. They start early in the year before native birds nest or they push out the native birds and claim a hole for themselves. **Lucy's Warbler** (a SGCN) uses cavities for its nest in the bosque. Starlings can take over the cavity, preventing the warbler from finding a successful place to raise chicks. Another factor reducing the holes available for nests is that there are fewer large cottonwoods and more small trees like saltcedar and Russian olives. These trees are not native to North

America but, since their introduction by humans along the Rio Grande, they are the most common plants in some areas. They never get large enough for woodpeckers to make their nest holes. Without cavities in the trees, many species are not able to nest and raise young. **(3.LS2.C; 3.LS4.D; MS.LS2.A)**

- *How do introduced species affect native species?*
- *Are there ways humans can help cavity-nesting birds?* **(5.ESS3.C)**
- *What happens if some of these native species are no longer here?* **(5.LS2.A)**

Bullfrogs, introduced into New Mexico by humans as a food source (frog legs!), are large and can eat other frogs or tadpoles, such as the **Northern Leopard Frog**. Bullfrog predation is one of many factors affecting the success of this native frog, considered a SGCN. **(Cause & Effect: Mechanism & Explanation; Stability & Change)**

- *How do introduced bullfrogs affect native species?* **(5.LS2.A)**
- *How might humans help reduce bullfrog effects on other species?* **(5.ESS3.C)**

♠ Do an additional round.

Swap animals and plants among students and include the Decomposer card this time.

- *How do decomposers fit in?*
- *If you didn't have decomposers, what would happen in the ecosystem?*
- *What is the role of decomposers in the web of life?* **(5.LS2.A; MS.LS2.B; Energy & Matter: Flows, Cycles & Conservation)**

Assessment:

- Return to the KWL charts. *What have students **Learned**? What additional questions do they have?*
- Design a bosque web of life based on what they know now.
- Have students draw "their" plant or animal along with other things it needs to survive, showing a web of life for that species.
- Do a group mural showing all the parts of the bosque ecosystem they have learned about. **(Systems & System Models; Energy & Matter: Flows, Cycles & Conservation; Developing & Using Models)**

Extensions:

- Have students identify non-living parts of the bosque ecosystem and the web of life they have created;
  - *What non-living factors are also necessary for these species to thrive?* (These might include soil type, temperature, fire, water amount and timing, etc.) **(3.LS2.C)**
- Have students highlight predators in the bosque:
  - *What role do predators play in this ecosystem?*
  - *What effect do predators have?* **(5.LS2.A; MS.LS2.A; Systems & System Models)**
- Think about competition between species:
  - *Are any species competing with each other?*
  - *What happens when species are competing for food, water, oxygen or*

other resources? For example, many species eat seeds on the ground. Some kinds of insects and mice are competing with birds such as the Spotted Towhee or Dark-eyed Junco for seeds on the ground. **(MS.LS2.A)**

- Research the plant or animal they have been in this activity, then write about it.
  - *What would a day or year in the life of this organism be?* **(Obtaining, Evaluating & Communicating Information)**
- Have your students think about human impacts in this bosque ecosystem. Students can research ideas they have about human impacts in the bosque.
  - *What sorts of human impacts would affect any of the species in the web of life they created? How would different species be impacted? How might humans mitigate these impacts?* Examples they might research: spraying to kill mosquitos, cutting down cottonwood trees, etc. **(5.ESS3.C; MS.ESS3.C; Cause & Effect: Mechanism & Explanation; Asking Questions & Defining Problems; Engaging in Argument from Evidence)**
  - *How would a change in the bosque plants or animals, such as those illustrated in this activity, affect humans? How does the biodiversity of our natural areas, such as the bosque, affect the lives of humans?* **(MS.LS4.D; Cause & Effect: Mechanism & Explanation)**
- Have students create short videos to share.

This activity could be paired with #46 "Energy in Bosque Ecosystems" to build on these concepts for 5th through middle school classes.

Resources:

Biota Information System of New Mexico (BISON-M) New Mexico Department of Game and Fish. https://bison-m.org

Kirkland, Jane. No Student Left Indoors—Creating a field guide to your Schoolyard. A Take a Walk Book. ISBN 13: 9780970975454

New Mexico Department of Game and Fish. 2016. State Wildlife Action Plan for New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

Porcupette (young North American Porcupine) in the bosque west of Valle de Oro National Wildlife Refuge
photo by Laurel Ladwig

NGSS Connections to The Web: Disciplinary Core Ideas

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.*

Students can gain an understanding of the range of living things in a bosque environment in "The Web" activity, a basis to then consider various changes to the environment and consider the effects of those changes. Use nest cavity availability as an example. *How does the limited availability of cavities affect species dependent on them?*

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

This activity looks closely at a bosque habitat; food, water, shelter, space that an organism needs to survive. By doing "The Web" activity, students make connections in this habitat, then can consider what happens if one part is not there. Mosquitoes provide food for other animals. If humans remove the mosquito by spraying pesticides illustrated by shaking the string) all other organisms will ultimately be affected.

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.*

This is a great activity to have students think about relationships in an ecosystem using the bosque as an example. They actively participate in thinking about food chains/food webs, specifically that some animals eat plants and others eat other animals. *What does each animal consume? What eats it?* Including the Decomposition card found in #46 "Energy in Bosque Ecosystems" activity will help understanding of decomposers in any ecosystem. The *Guide* has many examples of introduced species to illustrate their effects on the ecosystem. **Starlings** are an introduced species to North America. They are cavity nesters, using a hole in a tree that a woodpecker might have made. Starlings nest early in the season, occupying the cavities before others arrive, or they aggressively oust other birds from cavities they want. **Lucy's Warbler** is a SGCN in the bosque that uses cavities in trees to nest. Starlings can impact the nesting of this warbler.

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.*

Human activities have altered many habitats along the Rio Grande and its floodplain. Have students think about human impacts in this bosque ecosystem. Students can research ideas they have about human impacts in the bosque. *What sorts of human impacts would affect any of the species in the web of life they created?* Examples they might research include: spraying to kill mosquitoes, cutting down cottonwood trees, fires set by humans, habitat destruction, etc. *How are humans working to help protect the bosque and its species into the future? What engineering solutions are being implemented to protect the bosque into the future?*

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 vary across ecosystems, the patterns of interactions of organisms with their environments, both living and non-living, are shared.

This activity focuses on the interdependence of species in a bosque ecosystem by making connections in a web of life the students create. Try to get beyond "what eats what" in addressing this standard. Think of as many ways as you can in which one organism might need another: *Where will its home be? Does it need a place to perch to find food? Does it need the droppings of something to fertilize it?* Be creative in thinking of connections. Add non-living factors to achieve more of this standard (in Extensions). *Are any species competing with each other? What happens when species are competing for food, water, oxygen or other resources?* For example, many species eat seeds on the ground. Some kinds of insects are competing with birds such as the Spotted Towhee or Dark-eyed Junco for seeds on the ground. *What role do predators play in this ecosystem?* The yucca plant is a great example of mutually beneficial interactions becoming so interdependent that the yucca depends on the yucca moth for survival. Neither would be able to survive without the other. *Can you think of other mutually beneficial interactions among plants and animals?*

MS.LS2.B Cycles of Matter and Energy Transfer in Ecosystems *Food webs are models that demonstrate how matter and energy are transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organism in an ecosystem are cycled repeatedly between the living and non-living parts of the ecosystem.*

This activity is a good introduction to #46 "*Energy in Bosque Ecosystems"* activity. Students can be introduced to matter cycling in "*The Web"* to then puzzle through more complex ideas in the "*Energy in Bosque Ecosystems"* activity. One challenge is to tease apart the cycling of matter from the flow of energy in an ecosystem and the two activities together can give students the basis for this differentiation.

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.

"The Web" helps to illustrate the complexity of the biodiversity in a bosque ecosystem. Here, students can see the variety of connections between living organisms and then be challenged to see the effects of any changes. *If one aspect of the ecosystem is changed, are other organisms affected?* Use the example of the yucca and yucca moth. The

loss of one will cause the loss of the other. Another example to illustrate the importance of a variety of species in an ecosystem is to consider the opposite; single crop farming. In Ireland in the 1800s, many farmers were growing only potatoes; a potato blight moved through, destroying the plants and resulting in a great famine. A diverse ecosystem will be more resilient in surviving over the long term; a single outbreak of a pest will not affect the majority of living organisms. *What happens when we lose one of the organisms in an ecosystem? Can you think of other mutually beneficial interactions among plants and animals? In what specific ways might plants and animals depend on each other? What happens if one partner in this mutually beneficial relationship is lost?*

MS.LS4.D Biodiversity and Humans *Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.*
Humans are in control of many aspects of the bosque through management of the river and introduction of non-native species to this area. Through research in the last decades, we can see many effects on bosque species. *How would a change in the bosque plants or animals, such as those illustrated in this activity, affect humans? How does biodiversity of our natural areas, such as the bosque, affect the lives of humans?*

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.
Human activities have altered many habitats along the Rio Grande and its floodplain. Have students think about human impacts in this bosque ecosystem. Students can research ideas they have about human impacts in the bosque. *What sorts of human impacts would affect any of the species in the web of life they created?* Examples they might research include: spraying to kill mosquitoes, cutting down cottonwood trees, fire, water flows, habitat destruction, etc. *How are humans working to help protect the bosque and its species into the future? What engineering solutions are being implemented to protect the bosque into the future?*

Woodhouse Toad
Photograph by Letitia Morris

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