Appendix K: Standards Overview

New Mexico STEM Ready! and Next Generation Science Standards

The Rio Grande bosque is a dynamic and complex ecosystem, one that provides unique and essential habitats in this arid region. The primary focus of this *Guide* is to cultivate an understanding of how the bosque ecosystem functions. To that end, the main goal is to teach scientific concepts important to understanding this system and to support and promote the conservation and restoration of this valuable treasure. We hope you will use the *Guide* with this larger goal of understanding the bosque in mind, but in studying and learning about the bosque ecosystem your students can also address many of the New Mexico STEM Ready! Science Standards (NMSR!SS), as well as a number of New Mexico Common Core standards. The NMSR!SS include the Next Generation Science Standards (NGSS) adopted across the country plus six New Mexico-specific standards. Throughout this document, we generally refer to "NGSS" standards since the terms are used more widely, but note that NGSS in full is included in the New Mexico STEM Ready! Science Standards.

Your students will meet many of the performance expectations from the NGSS by engaging with Disciplinary Core Ideas (DCIs), Crosscutting Concepts (CCCs) and Science and Engineering Practices (SEPs) associated with each activity. To gain an understanding of how the bosque ecosystem works, we recommend that you do all of the core River of Change activities (Chapter 4) in the classroom, and also that you take your students out to the bosque at least once (see Chapter 3, "Going Out: Field Activities"). A field trip will help your students reflect on the real bosque compared to the model bosque they create in the classroom, and will help promote the multi-dimensional, phenomenon-based learning that is a goal of the NGSS. Additional classroom activities are provided that support the model-based, core activities of the program, and provide further opportunities to address the NGSS and the specific New Mexico standards. We encourage you to include as many of these in your lessons as you can.

In this overview, we will highlight those DCIs, CCCs and SEPs that apply to these activities. More detail, particularly for the DCIs, is included at the end of each activity, or unit for *Going Out* activities, and references are provided in the body of each activity to show where the standards fit. We encourage you to teach the full activity and not to focus only on a particular standard. For example, by completing the full River of Change unit, including all of the river model activities, you will address a number of these standards from different perspectives, which will promote students meeting the performance expectations. Field activities and school-based activities provide opportunities to address additional standards.

Enjoy the journey as you move through the *Bosque Education Guide* activities, and you will find that the many NGSS/NM STEM Ready! and Common Core standards can be met along the way!

Lesson number & title	1 Bosque Field Journals	2 Signs of Humans	3 Naturalist Notebooks	4 Wildlife Detectives	5 Crawly Creatures	6 Dip Net Critters	7 A Rose By Any Other Name	8 Reading the Bosque	9 Winter Buds
Disciplinary Core Ideas									
K-2.ETS1.B Developing Possible Solutions	X								
K.LS1.C Matter & Energy in Organisms									
K.ESS2.D Weather & Climate	X								
K.ESS2.E Biogeology	X								
K.ESS3.A Natural Resources									
K.ESS3.C Human Impacts	X								
1.LS1.A Structure & Function	X					X			X
1.LS1.B Growth & Development	X					X		X	
1.LS1.D Information Processing	X							X	
1.LS3.A Inheritance of Traits	X								
1.LS3.B Variation of Traits	X								
2.LS2.A Interdependent Relationships	X								
2.LS4.D Biodiversity & Humans	X								
3-5.ETS1.B Developing Possible Solutions	X								
3.LS1.B Growth & Development	X					X			
3.LS2.C Ecosystem Dynamics					X				
3.LS2.D Social Interactions	X							X	
3.LS3.B Variation of Traits	X								
3.LS4.C Adaptation	X*			X	X	X			
3.LS4.D Biodiversity & Humans	X			X	X				
3.ESS3.B Natural Hazards									
4.LS1.A Structure & Function	X				X*	X	X	X	X
4.LS1.D Information Processing	X							X	
4.ESS2.A Earth Materials & Systems									
4.ESS3.B Natural Hazards									
5.LS1.C Matter & Energy in Organisms	X*							X	
5.LS2.A Interdependent Relationships	X							X	
5.ESS3.C Human Impacts	X	X						X	
5.PS2.B Types of Interactions									
5.ETS2.A Science & Society									
5-SS-1 NM PE									
MS.LS1.B Growth & Development									
MS.LS2.A Interdependent Relationships								X	
MS.LS2.B Cycles of Matter & Energy Transfer									
MS.LS2.C Ecosystem Dynamics		X*			X	X		X	
MS.LS4.B Natural Selection									

Lesson number & title	1 Bosque Field Journals	2 Signs of Humans	3 Naturalist Notebooks	4 Wildlife Detectives	5 Crawly Creatures	6 Dip Net Critters	7 A Rose By Any Other Name	8 Reading the Bosque	9 Winter Buds
Disciplinary Core Ideas									
MS.LS4.D Biodiversity & Humans		X						X	
MS.ESS2.C Role of Water									
MS.ESS3.A Natural Resources									
MS.ESS3.C Human Impacts		X*				X*		X	
MS.ESS3.D Global Climate Change								X	X
MS.ETS2.B Influence of STEM		X*							
MS-ESS3-3 NM PE		X				X		X	
HS.LS2.A Interdependent Relationships									
HS.LS2.C Ecosystem Dynamics						X			
HS.LS4.D Biodiversity & Humans									
HS.ESS3.C Human Impacts									
HS.ESS3.D Global Climate Change									
HS.ETS1.A Engineering Problems									
HS.ETS1.B Developing Possible Solutions									
HS-LS2-7 NM PE									
HS-SS-2 NM PE									
Crosscutting Concepts									
Patterns	X		X			X	X	X	X
Cause & Effect		X				X*		X	
Scale, Proportion & Quantity									
Systems & System Models		X*				X			
Energy & Matter: Flows, Cycles & Conservation		X*						X	
Structure & Function	X				X	X	X		X
Stability & Change						X		X	
Science and Engineering Practices									
Asking Questions & Defining Problems								X	X
Developing & Using Models									X
Planning & Carrying Out Investigations			X						
Analyzing & Interpreting Data	X		X			X			
Using Mathematics & Computational Thinking			X						
Constructing Explanations & Designing Solutions	X					X		X	
Engaging in Argument & Evidence	X	X				X*		X*	
Obtaining, Evaluating & Communicating Information	X	X*							

** Indicates Extension activity;* *indicates New Mexico STEM Ready! Performance Expectation*

Lesson number & title	13 Changing River	14 Cottonwood Creation	15 Who Lives Where?	16 Who Grows Where?	17 Working Water	18 Bosque Chaos	19 The Web	20 Bosque Bugs Boogie	21 Bosque Survey	22 Mapping Species Richeness	23 Invasive Species	24 Crane Migration
Disciplinary Core Ideas												
K-2.ETS1.B Developing Possible Solutions												
K.LS1.C Matter & Energy in Organisms												X
K.ESS2.D Weather & Climate												
K.ESS2.E Biogeology												
K.ESS3.A Natural Resources												X
K.ESS3.C Human Impacts												X
1.LS1.A Structure & Function								X				X
1.LS1.B Growth & Development												X
1.LS1.D Information Processing								X				X
1.LS3.A Inheritance of Traits												
1.LS3.B Variation of Traits												
2.LS2.A Interdependent Relationships												
2.LS4.D Biodiversity & Humans												
3-5.ETS1.B Developing Possible Solutions												
3.LS1.B Growth & Development	X	X										X
3.LS2.C Ecosystem Dynamics	X	X	X	X		X	X					X
3.LS2.D Social Interactions			X*					X				X
3.LS3.B Variation of Traits												
3.LS4.C Adaptation	X	X	X	X		X						X
3.LS4.D Biodiversity & Humans	X	X	X	X		X	X					X
3.ESS3.B Natural Hazards	X					X						
4.LS1.A Structure & Function		X	X	X		X		X				X
4.LS1.D Information Processing								X				X
4.ESS2.A Earth Materials & Systems	X					X						
4.ESS3.B Natural Hazards	X					X						
5.LS1.C Matter & Energy in Organisms			X*									X
5.LS2.A Interdependent Relationships			X*	X*			X					
5.ESS3.C Human Impacts	X	X	X	X	X	X	X					X
5.PS2.B Types of Interactions					X							
5.ETS2.A Science & Society	X											X*
5-SS-1 NM PE	X											X*
MS.LS1.B Growth & Development		X	X	X								X
MS.LS2.A Interdependent Relationships	X	X	X	X			X			X	X	X
MS.LS2.B Cycles of Matter & Energy Transfer							X					
MS.LS2.C Ecosystem Dynamics	X	X	X	X		X	X			X	X	X
MS.LS4.B Natural Selection		X*										

Lesson number & title	13 Changing River	14 Cottonwood Creation	15 Who Lives Where?	16 Who Grows Where?	17 Working Water	18 Bosque Chaos	19 The Web	20 Bosque Bugs Boogie	21 Bosque Survey	22 Mapping Species Richness	23 Invasive Species	24 Crane Migration
Disciplinary Core Ideas												
MS.LS4.D Biodiversity & Humans	x		x	x			x*					
MS.ESS2.C Role of Water	x					x						
MS.ESS3.A Natural Resources	x											
MS.ESS3.C Human Impacts	x	x	x	x	x		x*				x	x
MS.ESS3.D Global Climate Change										x	x*	x*
MS.ETS2.B Influence of STEM	x				x							
MS-ESS3-3 NM PE	x	x	x	x	x							
HS.LS2.A Interdependent Relationships										x		
HS.LS2.C Ecosystem Dynamics										x	x	
HS.LS4.D Biodiversity & Humans										x	x	
HS.ESS3.C Human Impacts											x	
HS.ESS3.D Global Climate Change										x	x*	
HS.ETS1.A Engineering Problems											x	
HS.ETS1.B Developing Possible Solutions											x	
HS-LS2-7 NM PE											x	
HS-SS-2 NM PE											x	
Crosscutting Concepts												
Patterns	x	x	x	x		x	x	x		x	x	x
Cause & Effect	x	x	x	x	x	x	x			x	x	x
Scale, Proportion & Quantity	x	x				x						
Systems & System Models	x	x*	x*	x*	x	x	x					x
Energy & Matter: Flows, Cycles & Conservation	x		x	x		x	x					
Structure & Function		x	x	x		x		x			x	x
Stability & Change	x		x	x		x	x				x	x
Science and Engineering Practices												
Asking Questions & Defining Problems	x	x	x	x	x	x	x	x	x	x	x	x
Developing & Using Models	x	x	x	x	x	x	x	x		x		x
Planning & Carrying Out Investigations								x*				
Analyzing & Interpreting Data		x						x*	x	x		x*
Using Mathematics & Computational Thinking									x			
Constructing Explanations & Designing Solutions	x		x	x	x*	x		x		x	x	x
Engaging in Argument & Evidence	x		x	x			x*	x*		x	x	x
Obtaining, Evaluating & Communicating Information	x		x*	x*	x*	x*	x*	x*	x*	x*	x	

** Indicates Extension activity;* NM PE *indicates New Mexico STEM Ready! Performance Expectation*

When We Say Standards...

NMSR!SS = New Mexico STEM Ready! Science Standards
STEM = Science Technology Engineering Mathematics
NGSS = Next Generation Science Standards
DCIs = Disciplinary Core Ideas
CCCs = Crosscutting Concepts
SEPs = Science and Engineering Practices
PEs = Performance Expectations

Performance Expectations (PEs)

The writers of this *Guide* made a conscious decision not to highlight the connections to NGSS Performance Expectations (PEs). According to the architects of the NGSS, PEs are a "set of expectations for what students should be able to do by the end of instruction (years or grade-bands)." PEs are not day-to-day standards, but are end-points or targets that all instruction should point towards. By completing all of the River of Change activities, as well as field activities and additional classroom activities as time permits, your students will have multiple opportunities to address the DCIs, CCCs and SEPs that support the performance expectation goals. The New Mexico specific standard PEs are included below as they are part of the NMSR!SS

Disciplinary Core Ideas (DCIs)

Below is an overview of each of the DCIs that are addressed in the *Guide*, along with a reference to which activities apply. Included in each activity description are suggested discussion questions and prompts to help students understand the connection to the DCI. More detailed information is provided at the end of each activity. These prompts are suggestions and are not meant to be exclusive – encourage discussion and seek your own questions! Again, by encountering any given DCI in multiple activities, students will develop a broader understanding that will support meeting the performance expectations.

* means extension activity

Questions following the standards (e.g. · How do organisms grow and develop?) are from, A Framework for K-12 Science Education, Practices, Crosscutting Concepts, and Core Ideas. 2012. National Research Council, National Academies Press.

Elementary School DCI Connections

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?

• *What is the process for developing potential design solutions?*

Activity: Bosque Field Journals

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.

· *How do organisms obtain and use the matter and energy they need to live and grow?*

Activity: Ch. 3 Field Activities Crane Migration

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.

· *What regulates weather and climate?*

Activity: Bosque Field Journals

K.ESS2.E Biogeology

Plants and animals can change their environment.

· *How do living organisms alter Earth's processes and structures?*

Activity: Ch. 3 Field Activities

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.

· *How do humans depend on Earth's resources?*

Activity: Ch. 3 Field Activities Crane Migration

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.

· *How do humans change the planet?*

Activity: Bosque Field Journals Crane Migration

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.

· *How do the structures of organisms enable life's functions?*

Activities: Bosque Field Journals Dip Net Critters Winter Buds
Bosque Bugs Boogie Crane Migration

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.

· *How do organisms grow and develop?*

Activity: Bosque Field Journals Dip Net Critters Reading the Bosque
Crane Migration

1.LS1.D Information Processing

Animals have different 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.

· *How do organisms detect, process and use information about the environment?*

Activities: Bosque Field Journals Reading the Bosque Bosque Bugs Boogie
Crane Migration

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 the characteristics of one generation related to the previous generation?*

Activity: Bosque Field Journals

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.

· *Why do individuals of the same species vary in how they look, function and behave?*

Activity: Bosque Field Journals

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.

· *How do organisms interact with the living and nonliving environments to obtain matter and energy?*

Activity: Ch 3 Field Activities

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.

· *What is biodiversity, how do humans affect it, how does it affect humans?*

Activity: Bosque Field Journals

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.

· *What is the process for developing potential design solutions?*

Activity: Bosque Field Journals

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.

· *How do organisms grow and develop?*

Activities:	Bosque Field Journals	Dip Net Critters	Reading the Bosque
	Changing River	Cottonwood Creation	Crane Migration

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.

· *What happens to ecosystems when the environment changes?*

Activities:	Crawly Creatures	Changing River	Cottonwood Creation
	Who Lives Where?	Who Grows Where?	Bosque Chaos
	The Web	Crane Migration	

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.

· *5.l interact in groups so as to benefit individuals?*

Activities:	Bosque Field Journals	Reading the Bosque	Who Lives Where?*
	Bosque Bugs Boogie	Crane Migration	

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.

· *Why do individuals of the same species vary in how they look, function and behave?*

Activity: Bosque Field Journals

3.LS4.C Adaptation

For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.

· *How does the environment influence populations of organisms over multiple generations?*

Activities:	Bosque Field Journals*	Wildlife Detectives	Crawly Creatures
	Dip Net Critters	Changing River	Cottonwood Creation
	Who Lives Where?	Who Grows Where?	Bosque Chaos
	Crane Migration		

3.LS4.D Biodiversity and Humans

Populations live in a variety of habitats, and change in those habitats affects the organisms living there.

· *What is biodiversity, how do humans affect it, and how does it affect humans?*

Activities:	Bosque Field Journals	Wildlife Detectives	Crawly Creatures
	Changing River	Cottonwood Creation	Who Lives Where?
	Who Grows Where?	Bosque Chaos	The Web
	Crane Migration		

3.ESS3.B Natural Hazards

A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts.

· *How do natural hazards affect individuals and societies?*

Activities:	Changing River	Bosque Chaos

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.

· *How do the structures of organisms enable life's functions?*

Activities:	Bosque Field Journals	Crawly Creatures*	Dip Net Critters
	A Rose by Any Name	Reading the Bosque	Winter Buds
	Cottonwood Creation	Who Lives Where?	Who Grows Where?
	Bosque Chaos	Bosque Bugs Boogie	Crane Migration

4.LS1.D Information Processing

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

· *How do organisms detect, process and use information about the environment?*

Activities:	Bosque Field Journals	Reading the Bosque	Bosque Bugs Boogie
	Crane Migration		

4.ESS2.A Earth Materials and Systems

Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

· *How do Earth's major systems interact?*

Activities:	Changing River	Bosque Chaos

4.ESS3.B Natural Hazards

A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts.

· *How do natural hazards affect individuals and societies*

Activities:	Changing River	Bosque Chaos

5.LS1.C Organization for Matter and 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.

· *How do organisms obtain and use the matter and energy they need to live and grow?*

Activities: Bosque Field Journals* Reading the Bosque Who Lives Where?* Crane Migration

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.

· *How do organisms interact with the living and nonliving environments to obtain matter and energy?*

Activities: Bosque Field Journals Reading the Bosque Who Lives Where?* Who Grows Where?* The Web

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.

· *How do humans change the planet?*

Activities: Bosque Field Journals Signs of Humans Reading the Bosque Changing River Cottonwood Creation Who Lives Where? Who Grows Where? Working Water Bosque Chaos The Web Crane Migration

5.PS2.B Motion and Stability; Forces and Interactions; Types of Interactions

The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.

· *What underlying forces explain the variety of interactions observed?*

Activity: Working Water

5.ETS2.A Interdependence of Science, Engineering, and Technology

-Advances in science offer new capabilities, new materials or new understanding of processes that can be applied through engineering to produce advances in technology.

-Advances in technology, in turn provide scientists with new capabilities to probe the natural world at larger or smaller scales; to record, manage and analyze data; and to model ever more complex systems with greater precision.

-In addition, engineers' efforts to develop or improve technologies often raise new questions for scientists' investigation.

· *What are the relationships among science, engineering, and technology?*

Activities: Changing River Crane Migration*

Middle School DCI Connections

MS.LS1.B Growth, and Development of Organisms

-Animals engage in characteristic behaviors that increase the odds of reproduction.

-Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction

· *How do organisms grow and develop?*

Activities: Cottonwood Creation, Who Lives Where?, Who Grows Where?, Crane Migration

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.

· *How do organisms interact with the living and nonliving environments to obtain matter and energy?*

Activities: Reading the Bosque, Changing River, Cottonwood Creation, Who Lives Where?, Who Grows Where?, The Web, Invasive Species, Crane Migration, Mapping Species Richness

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.

· *How do matter and energy move through an ecosystem?*

Activity: The Web

MS.LS2.C Ecosystem Dynamics, Functioning & 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.

· *What happens to ecosystems when the environment changes?*

Activities: Signs of Humans*, Crawly Creatures, Dip Net Critters, Reading the Bosque, Changing River, Cottonwood Creation, Who Lives Where?, Who Grows Where?, Bosque Chaos, The Web, Crane Migration, Mapping Species Richness, Invasive Species

MS. LS4.B Natural Selection

Genetic variations among individuals in a population give some individuals an advantage in surviving and reproducing in their environment. This is known as natural selection. Natural Selection leads to the predominance of certain traits in a population, and the suppression of others.

· *How does genetic variation among organisms affect survival and reproduction?*

Activity: Cottonwood Creation*

MS.LS4.D Biodiversity & 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.

· *What is biodiversity, how do humans affect it, and how does it affect humans?*

Activities:	Signs of Humans	Reading the Bosque	Changing River
	Who Lives Where?	Who Grows Where?	The Web

MS.ESS2.C The Roles of Water in Earth's Surface Processes

Water continually cycles among land, ocean, and atmosphere via transpiration, condensation, and crystallization, and precipitation, as well as downhill flows on land.

-Global movements of water and its changes in form are propelled by sunlight and gravity.

-Water's movement on land cause weathering and erosion, which change the land's surface features.

· *How do the properties and movement of water shape the Earth's surface and affect its systems?*

Activities:	Changing River	Bosque Chaos

MS.ESS3.A Natural Resources

Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

· *How do humans depend on Earth's resources?*

Activity: Changing River

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.

· *How do humans change the planet?*

Activities:	Signs of Humans*	Dip Net Critters*	Reading the Bosque
	Changing River	Who Lives Where?	Who Grows Where?
	Cottonwood Creation	Working Water	The Web
	Crane Migration	Invasive Species	

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 the other kinds of knowledge, such as understanding of human behavior, and on applying that knowledge wisely in decisions and activities.

· *How do people model and predict the effects of human activities on Earth's climate?*

Activities:	Reading the Bosque	Winter Buds	Mapping Species Richness
	Invasive Species*	Crane Migration	

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.

· *How do science, engineering, and the technologies that result from them affect the ways in which people live? How do they affect the natural world?*

Activities: Signs of Humans* Changing River Working Water

High School DCI Connections

HS. LS2.A Interdependent Relationships in Ecosystems

Ecosystems have carrying capacities, which are limits to the number of organisms and populations they can support. These limits result from such factors as the availability of living and non-living resources and from such challenges as predation, competition, and disease.

· *How do organisms interact with the living and nonliving environments to obtain matter and energy?*

Activity: Mapping Species Richness

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 condition 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, over exploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.

· *What happens to ecosystems when the environment changes?*

Activities: Dip Net Critters Mapping Species Richness Invasive Species

HS.LS4.D Biodiversity and Humans

Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

· *What is biodiversity, how do humans affect it, and how does it affect humans?*

Activities: Mapping Species Richness Invasive Species

HS.ESS3.C Human Impacts on Earth Systems

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

-Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

· *How do humans change the planet?*

Activity: Invasive Species

HS.ESS3.D Global Climate Change

Though the magnitude of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.

· *How do people model and predict the effects of human activities on Earth's climate?*

Activities: Invasive Species Mapping Species Richness

Crosscutting Concepts (CCCs)

Crosscutting Concepts are intended to help students make connections and broaden their understanding across different areas of disciplinary study. By their very nature, they are meant to apply to a variety of activities and to be revisited often during the course of study. We provide suggestions for applying CCCs to the lessons in the *Guide*. We have included prompts in the descriptions of each activity that show where CCCs might apply. We encourage you to look for more connections as you explore these activities!

Patterns

Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

The Rio Grande once experienced temporal (time: seasonal or annual) patterns in flooding that structured floodplain ecosystems and determined the species that survived there. Flooding created spatial patterns in habitats, but random chance also influenced these patterns. For example, consider the shape of the river channel in Bravo, Manso, Nuevo. Look for patterns in the distribution of different plant species based on local conditions or similar adaptations of organisms depending on their habitat.

Cause and Effect: Mechanism & Explanation

Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Prior to human alterations, flooding along the Rio Grande was caused by heavy snowfall or precipitation in the mountains. These events impacted the distribution of habitats along the floodplain, and determined which organisms could live there. Changes to the hydrology and increased use of the floodplain have increase the frequency and severity of fires.

Students can write a Claim, Evidence, Reasoning statement about a variety of topics, such as

- *The effect of flooding on the bosque.*
- *The effect of dams/levees/jettyjacks on the river and bosque.*
- *The effect of removing flooding or lowering the groundwater on the risk of fire.*

Scale, Proportion, and Quantity

In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion or quantity affect a system's structure or performance.

The Rio Grande was once a dynamic system that changed greatly over time and space within the floodplain. Changes were much less predictable at a small spatial or temporal (time) scale, but habitats were predictable when considered over a longer time or larger area. Consider the natural annual cycle of the river, and variation that was present both temporally and spatially. Consider how the floodplain changed over time and space, and how this dynamic system was changed by human activity.

Systems and System Models

Defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering.

These activities model a system—the bosque ecosystem. Use the lens of systems to learn about this ecosystem through each of these Changing River activities. In this context, a system could be as big as the whole floodplain or as small as a single organism, like a cottonwood tree. Brainstorm with students: Boundaries, components, interactions, inputs and outputs, and properties.

Here are more tips for using a Systems lens:

1. Look for the bigger picture.
2. Study systems from multiple perspectives.
3. Consider the role of short and long time frames.
4. Search for complex cause and effect relationships.
5. Explore places where systems connect with other systems.

--WestEd / *Making Sense of Science*

Energy & Matter: Flows, Cycles and Conservation

Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

Both animals, or plants, can provide an excellent path to understanding both matter and energy in ecosystems.

How do animals get the energy and matter they need? What about plants?

Consider the activity of animals / plants to observe how energy or matter might be transported into, out of, or within an ecosystem.

Structure and Function

The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

Consider both plants and animals.

How does an organism's shape affect the way it lives and operates, and in turn the way it survives?
How are different species similar or different in the way they are shaped and how they function?
Are any particular structures more suited to life along the river or in the bosque?

Stability and Change

For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

The Rio Grande floodplain is an inherently dynamic system, with both temporal (time) and spatial changes occurring regularly, but often in a random fashion. Stability is observed when one looks at a larger spatial and temporal scale. Seemingly simple changes such as removing flooding and lowering the groundwater have dramatically impacted the bosque. Consider the natural annual cycle and also changes after human alterations in the floodplain.

Science and Engineering Practices (SEPs)

Science and Engineering Practices provide students with an opportunity to experience how scientists and engineers go about doing their jobs, including learning both the general skills required and also the basic knowledge needed to carry out their studies. Like the CCCs, SEPs apply across many of the activities in this *Guide*. Here we provide some general suggestions on how to fit these into your lesson plans.

Asking Questions and Defining Problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and that can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify the ideas of others.

Science is not a collection of facts, but a process of exploration that is driven by questions and leads to more questions. Students need to learn to be comfortable with asking questions and exploring ideas without feeling that an answer is the endpoint of their learning. For any of these activities, you can begin with students creating KWL charts. You can start this chart with the Changing River activity, and then add new questions with each of the new activities. This can be started with a **think, pair, share**. Students have a few minutes to think about the topic and write a few ideas down; then discuss and continue to brainstorm with another student or small group, then share with the whole class.

For example, ask the question:

--*What do we **Know** about the bosque?*

-- *What do we **Want** to know about the bosque?*

Then after the lesson they answer,

--*What have we **Learned** about the bosque?*

Through this process, you prime your students for learning, and you can include activities that will help answer their questions. You probably want to come back to the chart frequently—to show what they have learned and to add their new questions!

Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.

The core activities of the *Guide* focus on the use of the river model to illustrate concepts related to the river and floodplain ecology. Students model the bosque ecosystem under the three different river conditions through time – Rio Bravo, Rio Manso and Rio Nuevo. The model illustrates how human alterations have changed the ecosystem, and how people can make further changes to keep as many aspects of Rio Bravo as possible into the future. Different activities include different components of the ecosystem, such as where plants and animals live or the changing role of chance or fire in the bosque. Students will model part of the life cycle of the cottonwood tree. Have students discuss the benefits and limitations of any model they use.

Assessment: After building the class model of the bosque ecosystem, students can make their own model illustrating the three rivers over time, or some particular aspect of the river as studied in these activities. They can draw on paper or white board, make 3-D model, video or photos, etc. This type of assessment can apply to any of the activities individually, or to the unit as whole.

Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed to derive meaning. Scientists use a range of tools to identify significant features and patterns in the data. Engineering investigations include analysis of data collected in tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria.

Several activities include opportunities to analyze and interpret data, particularly data collected during field trips such as using *Naturalist Notebooks*. Classroom activities provide additional opportunities.

Constructing Explanations and Designing Solutions

The goal of science is the construction of theories that provide explanatory accounts of the material world. The goal of engineering design is a systematic approach to solving engineering problems that is based on scientific knowledge and models of the material world.

There are numerous opportunities for students to construct theories explaining phenomena related to the river and bosque, or to design solutions to engineering problems. This applies across all of the activities. For example, they can construct theories about how likely it is that the cottonwood bosque will survive as it is today, or to explain the effect of dams/levees/jettyjacks on the river. They can design solutions for how to solve the problem of restoring the natural hydrology or improving habitat or decreasing the impact of fire.

Engaging in Argument from Evidence

In science, reasoning and argument are essential for clarifying strengths and weaknesses of a line of evidence and for identifying the best explanation for a natural phenomenon. In engineering, reasoning and arguments are essential for finding the best solution to a problem. Engineers collaborate with their peers throughout the design process.

This SEP can be addressed with any of the core activities. We suggest using a Claim, Evidence, Reasoning (CER) framework as an assessment tool. For example, consider the effect of flooding on the bosque, or the increase in fires due to lack of flooding, or the role that land managers can play in restoring the health of floodplain ecosystems.

Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions.
Statistical methods are frequently used to identify significant patterns and establish correlational relationships.

Obtaining, Evaluating, and Communicating Information

Science advances when scientists are able to communicate their findings clearly and persuasively, and learn about the findings of others. Engineering produces new or improved technologies when the advantages of their designs are communicated clearly and persuasively.

This SEP can be addressed as an extension or assessment to any of the core activities. Suggestions for topics are included for each activity. Share these ideas orally, or by writing letters, flyers, posters or books (connect to ELA/Common Core Standards).

New Mexico Specific 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 Bosque Education Guide activities.

5. Science and Society

Performance Expectation 5-SS-1 NM

Communicate information gathered from books, reliable media, or outside sources, that describes how a variety of scientists and engineers across New Mexico have improved existing technologies, developed new ones, or improved society through applications of science.

DCI: 5.ETS2.A Interdependence of Science, Engineering, and Technology

-Advances in science offer new capabilities, new materials or new understanding of processes that can be applied through engineering to produce advances in technology.

-Advances in technology, in turn provide scientists with new capabilities to probe the natural world at larger or smaller scales; to record, manage and analyze data; and to model ever more complex systems with greater precision.

-In addition, engineers' efforts to develop or improve technologies often raise new questions for scientists' investigation.

CCC: Science is a Human Endeavor

- *Men and women from all cultures and backgrounds choose careers as scientists and engineers.*
- *Most scientists and engineers work in teams.*
- *Science affects everyday life.*
- *Creativity and imagination are important to science.*

CCC: Science is a Way of Knowing.

- *Science is both a body of knowledge and process that add new knowledge.*
- *Science is a way of knowing that is used by many people.*

SEP: Obtaining, Evaluating & Communicating Information

Activity: Changing River

MS. Human Impacts

Performance Expectation MS-ESS3-3 NM

Describe the advantages and disadvantages associated with technologies related to local industries and energy production. [Clarification statement: Examples may include examining short and long term impacts of related technologies on water usage (such as 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.]

DCI: MS.ESS3.A Natural Resources

Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

DCI: MS.ESS3.C Human Impacts on Earth Systems

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

DCI: 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.

CCCs: Cause & Effect; Systems & System Models

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

Activities: Signs of Humans, Changing River, Who Grows Where?, Dip Net Critters, Cottonwood Creation, Working Water, Reading the Bosque, Who Lives Where?

HS. Interdependent Relationships in Ecosystems

Performance Expectation HS-LS2-7 NM.

Using a local issue in your solution, design and analyze the advantages and disadvantages of human activities that support the local population such as reclamation projects, building dams, and habitat restoration.

HS.LS2.C Ecosystem Dynamics, Functioning and 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.

HS.LS4.D Biodiversity and Humans

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ETS1.B Developing Possible Solutions

When evaluating solutions, it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.

CCC: Stability and Change

SEP: Constructing Explanations and Designing Solutions

Activity: Dip Net Critters, Invasive Species

HS. Science and Society

Performance Expectation HS-SS-2 NM

Construct an argument using claims, scientific evidence, and reasoning that helps decision makers with a New Mexico challenge or opportunity as it relates to science.

ETS 1.A Defining and Delimiting Engineering Problems

-Criteria and constraints also include satisfying any requirements set by society such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.

-Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.

ETS 1.B Developing Possible Solutions

When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.

CCC: Cause and Effect

SEP: Engaging in Argument from Evidence

Connections to Nature of Science

Scientific Knowledge is Open to Revision in Light of New Evidence

-Most scientific knowledge is quite durable but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.

-Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.

Science Addresses Questions about the Natural and Material World

-Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions.

-Science knowledge indicates what can happen in natural systems— not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge

Activity: Invasive Species

Common Core Connections

Text Types & Purposes

Production & Distribution of Writing

Research to Build and Present Knowledge

Reading Informational Texts*

Vocabulary Acquisition and Use*

English Language Arts Standards Grade 3

Reading: Informational Text:

CCSS.ELA-LITERACY.RI.3.1 Ask and answer questions

CCSS.ELA-LITERACY.RI.3.2 Determine the main idea

CCSS.ELA-LITERACY.RI.3.3 Describe the relationship between a series of events or ideas

Writing:

CCSS.ELA-LITERACY.W.3.2 Write informative/explanatory texts

CCSS.ELA-LITERACY.W.3.4 Produce writing appropriate to task and purpose

CCSS.ELA-LITERACY.W.3.5 Develop and strengthen writing as needed

CCSS.ELA-LITERACY.W.3.6 Use technology to produce and publish writing

CCSS.ELA-LITERACY.W.3.7 Conduct short research projects that build knowledge

CCSS.ELA-LITERACY.W.3.8 Recall information from experiences or gather information

Speaking and Listening:

CCSS.ELA-LITERACY.SL.3.1 Engage effectively in a range of collaborative discussions

English Language Arts Standards Grade 4

Reading: Informational Text:

CCSS.ELA-LITERACY.RI.4.1 Refer to details and examples in a text

CCSS.ELA-LITERACY.RI.4.2 Determine the main idea of a text

CCSS.ELA-LITERACY.RI.4.3 Explain events, procedures, ideas, or concepts

CCSS.ELA-LITERACY.RI.4.7 Interpret information presented visually, orally, quantitatively

Writing:

CCSS.ELA-LITERACY.W.4.2 Write informative/explanatory texts

CCSS.ELA-LITERACY.W.4.7 Conduct short research projects that build knowledge

CCSS.ELA-LITERACY.W.4.8 Recall relevant information from experiences

Speaking and Listening:

CCSS.ELA-LITERACY.SL.4.1 Engage effectively in a range of collaborative discussions

CCSS.ELA-LITERACY.SL.4.4 Report on a topic or text, tell a story, or recount an experience

Language:

CCSS.ELA-LITERACY.L.4.6 Acquire and use accurately grade-appropriate words, phrases

English Language Arts Standards Grade 5

Reading: Informational Text:

CCSS.ELA-LITERACY.RI.5.1 Quote accurately from a text when explaining the text

CCSS.ELA-LITERACY.RI.5.2 Determine two or more main ideas of a text, summarize text

CCSS.ELA-LITERACY.RI.5.3 Explain the relationships or interactions based on texts

CCSS.ELA-LITERACY.RI.5.9 Integrate information from several texts on the same topic

Writing:

CCSS.ELA-LITERACY.W.5.1 Write opinion pieces on topics or texts based on information

CCSS.ELA-LITERACY.W.5.2 Write informative/explanatory texts to examine a topic

CCSS.ELA-LITERACY.W.5.7 Conduct short research projects that use several sources

Math Standards

Several activities provide opportunities to use graphs and charts to represent and interpret data as well as opportunities for measurement in various ways. Scientists use math all of the time.

Measurement & Data

5.MD Represent & Interpret Data

Statistics and Probability

6.SP Develop understanding of statistical variability; Summarize & describe distributions

Activity: Naturalist Notebooks Bosque Survey

7.SP Use random sampling to draw inferences about a population; Draw informal comparative inferences about two populations.

Activity: Naturalist Notebooks Bosque Survey

Geography Standards

Geographic Representations & Reasoning