

**An Educator's Resource Guide to Earth
Systems in a Grassland Ecosystem
Next Generation Science Standard-Based
Lessons for Grades 9-12**

UNIVERSITY OF
Nebraska
Lincoln



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Systems in a Grassland Ecosystem
Next Generation Science Standard-Based
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**Grasslands Artifact Roadshow
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About the Grasslands Artifact Roadshow Project

The Grasslands Artifact Roadshow is a citizen science research project in collaboration between the University of Nebraska-Lincoln and the US Forest Service. The primary goal of the Grasslands Artifact Roadshow is to connect private artifact collectors with professional archaeologists to document and identify stone tools. Most archaeological research is done on public land, which is just a small portion of the United States. Collaboration with private landowners and collectors helps to fill the gap in research and provide new insight about the prehistoric inhabitants of the Great Plains. Roadshow events are held in local communities in Nebraska and Around the Great Plains. During events, collectors are invited to bring in their artifacts to be identified and documented.

The lessons in this guide use data collected during Grassland Artifact Roadshow Events. All projectile point scans can be found on the Grasslands Artifact Roadshow website in the 2D Archives section. Educators, students, and researchers are invited to use data collected from events for educational and research purposes.

About This Guide

This guide contains five lesson packets with a total of 29 lessons and supporting materials to explore America's grasslands from an Earth's spheres approach. Lessons are aligned with Next Generation Science Standards for grades 9-12 but can be used in both a formal and informal setting. This guide is designed to be used in conjunction with supporting course materials and provide educators with unique activities to engage students in otherwise underrepresented topics.

The guide is structured by individual section with lessons and lesson materials. Each section includes background information for educators meant to provide a brief introduction to the topic. Additional resources to further explore the subject matter are provided at the end of each lesson. Sections include an introduction lesson to provide students background information and explore the topic. Subsequent lessons are designed to build on previously learned knowledge. With some adaptation, lessons can be used independently. Supplementary activities and lessons are provided at the end of each lesson.

This guide and lessons demonstrate the theory of everything being connected and rely heavily on critical thinking and class discussion. Students will need draw on previous knowledge and experiences to participate in discussions and complete projects.

Anthroposphere



Anthroposphere

This packet contains four sections with seven lessons to investigate the interaction between humans and the Grasslands of the United States.

The Anthroposphere is part of Earth that is made or modified by humans for use in human activities and habitats. While humans are also part of the Biosphere, it is important to consider the human interactions separate when looking at natural resources. Humans have a long history with the grasslands and have been living in and modifying the grasslands for at least 12,000 years. For thousands of years, humans have inhabited the prairie, hunting, gathering, and farming. Prehistoric people moved throughout the grasslands following megafauna grazers such as bison and mammoths. As megafauna died off, prehistoric people found different food sources and started growing crops. Additionally, Indigenous people set fire to the grasslands annually to promote new plant growth. In more recent times, humans have converted the nutrient rich prairie into agricultural land. In 1862, the federal government enacted the Homestead Act and settlers moved west to stake their claim on the land. The homesteaders began to convert the native grasses into cropland. However, unsustainable farming practices and loss of native grasses eventually led to the Dustbowl in the 1930s.

Sections:

1. Great Plains Images
2. Human Dimensions of the Grasslands
3. Fire Frenzy
 - Humans and Fire
 - Fire and Nature
 - Town Hall Meeting
4. Great Plains Oral History
 - Community Background
 - Land Talk Interview and Report

Great Plains Images

In this lesson, students will explore life and human dimensions of the Great Plains through prehistoric, historic, and current art pieces. Lessons are geared towards grades 9-12.

Art is important to the culture of the Great Plains and has been used by numerous cultures for centuries as a form of visual representation of life on the Great Plains.¹ When discussing art in the Great Plains, there two sectors commonly discussed, Native American and European American art. Although both cultures created art, they are often considered separately because of the differences in culture, vision, representation, and relationship with the land.¹ Great Plains art can be used to study past generations and their interactions with people, land, plants, and animals. Art of various mediums has been identified and studied throughout the Great Plains. Visual art can provide context and insight to past cultures and land management. Photographs of the Dust Bowl may be the best representation of poor land management in the Great Plains. By studying such images, we can learn from previous mistakes and implement better natural resource management practices.

References:

1. Wishart, D. J. (n.d.). Art. Encyclopedia of the Great Plains. Retrieved from: <http://plainshumanities.unl.edu/encyclopedia/doc/egp.art.001>

Activities:

- Class discussion to gauge prior knowledge of the human interactions on the Great Plains and art of the Great Plains
- Background reading on the Great Plains
- Great Plains images, students will search for an image that represents life on the Great plains and create an image that represents life on the Great Plains
- Presentation, students will create a presentation about the images they found and created

Great Plains Images

Grade/ Grade Band: 9-12	Topic: Natural Resources/ Environmental Science	Lesson # 1 in a series of 1 lesson
<p>Brief Lesson Description: Art is important to the culture of the Great Plains. In this lesson, students will explore the human dimensions of the Great Plains by researching significant images from the Great Plains, creating their own image of the Great Plains, and creating a presentation about the images.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Describe the significance of humans living in the Great Plains 2. Create an image that portrays life on the Great Plains 3. Explain the human interactions with and use of natural resources available in the Great Plains 		
<p>NGSS Standards: SC.HS.15 Sustainability SC.HS.15.5 Gather, analyze, and communicate evidence to describe the interactions between society, environment, and economy.</p>		
<p>Narrative / Background Information</p>		
<p>Prior Student Knowledge: Earth science basics, natural resource basics</p> <p>Art can be a valuable source of knowledge about past generations. Great Plains art can be used to study past generations and their interactions with people, land, plants, and animals. Photographs of the Dust Bowl may be the best representation of poor land management in the Great Plains. By studying such images, we can learn from previous mistakes and implement better natural resource management practices.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Asking Questions and Defining Problems • Obtaining, Evaluating, and Communicating Information 	<p>Disciplinary Core Ideas: SC.HS.15.5.A Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Patterns • Cause and Effect • Stability and Change
<p>Possible Preconceptions/Misconceptions: Students may not understand how art can portray significant events or be used for scientific purposes.</p>		
<p>LESSON PLAN – 5-E Model</p>		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Class Discussion:</u> Students will participate in an in-depth discussion about human interactions with natural resources on the Great Plains. Use the following questions to lead discussion:</p> <ul style="list-style-type: none"> • How long do you think humans have lived on the Great Plains? • What are some examples natural resources available on the Great Plains? • How do humans use the natural resources on the Great Plains? • How have humans changed the Great Plains? • What do you think life on the Great Plains was like 50 years ago? 100 years ago? 1000 years ago? • What do people make art? • What does art have to do with natural resources and earth science? • What can we learn from looking at images from the past? 		
<p><u>Background Reading:</u> Students will read this Great Plains background page from Britannica https://www.britannica.com/place/Great-Plains</p>		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> • Paper • Pencil • Computers with internet access <p>Before the lesson, print or send project instructions and template.</p>		
<p><u>Image Search:</u> After reading background information on the Great Plains, students will search for images of the Great Plains. The images can be from any time period or culture and can depict human life on the Great Plains, grassland ecosystems, or plants and animals of the Great Plains. The image can be a photo, painting, portrait, or sculpture. Once students have identified an image, they will research the origin of the image.</p>		
<p><u>Image Creation:</u> Students should brainstorm themes and ideas to portray the Great Plains. Possible themes include natural resources,</p>		

human interactions, human life, an ecosystem, plant and animal life, etc.
Students can choose any medium to create their image—photo, drawing, painting, etc.
The only criteria for this activity are to be creative and portray the Great Plains.

Presentation: Students will create a presentation with a 10-minute time limit. The presentation will be in two sections. The first section will cover the image found and researched. The second section will cover the image created.

Students should follow this template:

Section One:

- Image from the Great Plains
- Original creator
- What the image represents—culture, time period, location, individuals, natural resources, human interactions
- Accuracy—does the image accurately represent the Great Plains?
- Where the image was found

Section Two:

- Created image of the Great Plains
- What the image represents—culture, time period, location, individuals, natural resources, human interactions
- What does the image mean to you?
- Accuracy—does the image accurately represent the Great Plains?

EXPLAIN: Concepts Explained and Vocabulary Defined:

Explain how images and art can portray significant events
Explain how scientists can use art and images to communicate or show significant events
Explain what can be learned from studying images from the past

Vocabulary:

Human Dimensions- a field of study relating to the human knowledge and attitude of natural resources
Great Plains- a prairie landscape region between the Rocky Mountains and the Mississippi River
Natural Resources- materials or substances that occur in nature and exist without actions from humans

ELABORATE: Applications and Extensions:

- **Anthroposphere, Fire Frenzy**
- **Anthroposphere, Human Dimensions of the Great Plains**
- **Anthroposphere, Great Plains Oral History**

EVALUATE:

Summative Assessment (Quiz / Project / Report):

At the end of the lesson, students will be able to:

1. Identify the significance of art in the Great Plains
2. Describe the interaction between humans and nature in the Great Plains
3. Explain how the availability of resources influences human activity

Additional Resources:

Great Plains Photo Gallery: <https://www.loc.gov/photos/?fa=subject%3Agreat+plains%7Clocation%3Agreat+plains&sp=1&st=gallery>
Derrald Farnsworth-Livingston Great Plains Photos: <http://www.journeyoflight.com/photo-gallery/midwest>
Nebraska History- Great Plains: <https://history.nebraska.gov/tags/great-plains>
Great Plains Art: <http://plainshumanities.unl.edu/encyclopedia/doc/egp.art.001>

Human Dimensions of the Grasslands

In this lesson, students will explore how humans interact with and have changed grassland ecosystems by participating in a probing exercise. Lessons are geared towards grades 9-12.

Every continent, except Antarctica, is home to grasslands. In the North America these grasslands are often called prairies. In Africa grasslands are called savannas, in Europe they are called steppes, in South America they are all called pampas.^{1,2} Approximately a quarter of the land on earth is grassland.² There are two types of grasslands- tropical, near the equator, and temperate, further from the equator. In the United States there are three primary types of prairies: short grass, mixed grass, and tall grass, each with unique plants and animals. There are 20 national grasslands in the United States, totaling almost four million acres.³ The grasslands are publicly owned and managed by the United States Forest Service. 17 of the grasslands are located between the Rocky Mountains and the Mississippi River.³ Humans and the grasslands have an important history. For thousands of years, humans have inhabited the prairie, hunting, gathering, and farming. Prehistoric people moved throughout the grasslands following megafauna grazers such as bison and mammoths. As megafauna died off, prehistoric people found different food sources and started growing crops. Additionally, Indigenous people set fire to the grasslands annually to promote new plant growth. In more recent times, humans have converted the nutrient rich prairie into agricultural land. In 1862, the federal government enacted the Homestead Act and settlers moved west to stake their claim on the land.³ The homesteaders began to convert the native grasses into cropland. However, unsustainable farming practices and loss of native grasses eventually led to the Dustbowl in the 1930s.³

References:

1. Grasslands. (n.d.) Grasslands of the World. Retrieved from <http://www.mbgnet.net/sets/grasslnd/world.htm>
2. Grasslands. (n.d.) National Geographic. Retrieved from <https://www.nationalgeographic.com/environment/habitats/grasslands/>
3. Hecker, L. & Scott, I. (2013). National Grasslands Interpretive Master Plan. USDA Forest Service [PDF] retrieved from https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5439005.pdf

Activities:

- Photo probing activity to encourage critical thinking about how humans interact with the grasslands
- Students will look at photos of different landscapes and write their initial thoughts
- Class discussion on how climate and humans have changed the grasslands ecosystem

Humans and the Grasslands

Grade/ Grade Band: 9-12	Topic: Natural Resources/ Environmental Science	Lesson # 1 in a series of 1 lesson
<p>Brief Lesson Description: Grasslands are a diverse ecosystem that encompass all four of earth's spheres: the biosphere, hydrosphere, lithosphere, and atmosphere. The biosphere includes all living creatures, even humans. In this lesson, students will explore how humans interact with the grasslands.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Identify how humans interact with the grasslands. 2. Identify how climate has changed the grasslands ecosystems on a long-term scale 		
<p>NGSS Standards: SC.HS.7 Interdependent Relationships in Ecosystems SC.HS.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic ecology knowledge</p> <p>Every continent, except Antarctica, is home to <u>grasslands</u>. In the North America these grasslands are often called prairies. In the United States there are three primary types of prairies, short grass, mixed grass, and tall grass, each with unique plants and animals. There are 20 national grasslands in the United States, totaling almost four million acres. Humans and the grasslands have an important history. For thousands of years, humans have inhabited the prairie, hunting, gathering, and farming. In more recent times, humans have converted the nutrient rich prairie into agricultural land. In 1862, the federal government enacted the Homestead Act and settlers moved west to stake their claim on the land. The homesteaders began to convert the native grasses into cropland. Unsustainable farming practices and loss of native grasses eventually led to the <u>Dustbowl</u> in the 1930s.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	<p>Disciplinary Core Ideas: SC.HS.7.2.E Design, evaluate, and refine a solution for increasing the positive impacts of human activities on the environment and biodiversity.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Patterns • Cause & effect
<p>Possible Preconceptions/Misconceptions: Students may view the grassland as a boring, wasteland. Students may not know about the rich biodiversity of grassland ecosystems.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Photo First Impressions:</u> Students should take out a pencil and paper to write their responses. Show students the photos in the following order. Ask students to write their first impression when viewing the photo (Only show each photo for about 10 seconds) Show photos in the following order:</p> <ol style="list-style-type: none"> 1. Mountains 2. Forest 3. Grasslands 4. Agricultural land 5. Dustbowl <p>After students have finished writing, break into groups of two or three. Each group should discuss their thoughts on the photos. While students are discussing, write categories for the different landscapes (forest, mountains, grasslands, agricultural land) on the board. As a class, students will vote for their favorite landscape, tally the votes and write the number under each category. It is likely that students will vote for forest and mountains are their favorite landscape, this is perfectly okay. Students will have an opportunity to get a closer look at grasslands in the next section.</p> <p><u>Grassland Probe:</u> Students will share their knowledge and understanding of the grasslands. Ask students the follow questions about the grasslands:</p> <ul style="list-style-type: none"> • What were your initial thoughts on the grasslands? • What do you know about grasslands? • Where are grasslands located? Have you ever been to a national grasslands site? <p>Show students a map of national grassland locations in the United States. Provide students with fast facts on grasslands in the United States. Show additional photos of animals and plants endemic to the grasslands and ask students to provide their thoughts on grassland ecosystems.</p>		

Use the following questions to guide discussion:

- Based on the photos we looked at, how do you think humans have changed the grasslands?
- What do you think caused the dustbowl?
- Why do you think grasslands were converted to agricultural land?
- What other non-human forces have resulted in changes to the grasslands?

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:

Lesson Materials & Preparations:

- Grassland photos and map (located in lesson materials)
- Paper
- Pencil

Print or project map and photos from lesson materials

Grassland Exploration: Students will explore online resources to identify how grasslands have been changed by humans and natural forces. Students will choose one of the following topics to explore and write a short report on.

Grassland report topics:

- Land use change (native grasses to cropland)
- Climate change
- Dust bowl
- Biodiversity of plants and animals

The report should cover the following criteria:

- Well defined topic
- Human impacts on the ecosystem
- Examples of how humans have altered the grasslands
- Photos

EXPLAIN: Concepts Explained and Vocabulary Defined:

Explain why humans have changed the grasslands.

Explain how climate has changed grassland ecosystems.

Review lesson vocabulary.

Vocabulary:

Grassland- an area that is dominated by grass or grass-like vegetation

Biosphere- the parts of the earth in which organisms are able to live

Dust bowl- an area of land in Kansas, Oklahoma, and Texas where vegetation was lost, and severe soil erosion occurred in the 1930s

Ecosystem- a biological community of interacting organisms in their physical environment

ELABORATE: Applications and Extensions:

- **Anthroposphere, Fire Frenzy**
- **Anthroposphere, Great Plains Images**

EVALUATE:

Summative Assessment (Quiz / Project / Report): Grasslands Exploration report

At the end of the lesson students will be able to:

- Identify how humans have changed the grasslands in the United States.
- Explain why humans have changed the grasslands in the United States.
- Identify ecological impacts of losing native grasslands.

Additional Resources:

Grassland Facts: <https://www.nationalgeographic.com/environment/habitats/grasslands/>

Grassland Facts: <https://www.britannica.com/science/grassland>

National Grasslands: <https://www.fs.fed.us/grasslands/>

The National Grasslands Story: <https://www.fs.fed.us/grasslands/aboutus/index.shtml>

Dust Bowl Interactives: <https://www.pbs.org/kenburns/dustbowl/interactive/>

Dust Bowl: <https://www.thoughtco.com/worst-us-environmental-disasters-1203696>

Great Plains Land Use: <https://naldc.nal.usda.gov/download/CAT93992048/PDF>

Lesson Materials:
Images for Part 1:
Forest



USDA Forest Service

Mountains



Chester Photography (retrieved from: <https://www.goodfreephotos.com/bolivia/other-bolivia/mountains-and-lake-landscape-scenic.jpg.php>)

Grasslands



Tom Engberg, NPS Photo (Retrieved from <https://www.nps.gov/hocu/learn/news/2017-grassland-conversion-plan.htm>)

Agricultural Land



Retrieved from <https://www.pikrepo.com/fddfz/yellow-tractor-on-brown-field-during-daytime>

Dustbowl



George E. Marsh, NOAA

Images for Part 2:

Map of Grasslands in the United States



USDA Forest Service

Bison



NPS Photo (Retrieved from <https://www.nps.gov/wica/learn/nature/bison-buffalo-bison-bison.htm>)

Swift Fox



Craig Miller, BLM Photo (Retrieved from <https://www.flickr.com/photos/mypubliclands/3026577655/>)

Monarch Butterfly



Billings Brett, USFWS (Retrieved from <https://pixnio.com/fauna-animals/insects-and-bugs/butterflies-and-moths-pictures/monarch-butterfly/orange-colored-insect-monarch-butterfly>)

Burrowing Owl



Emily Reif, Grasslands Artifact Roadshow

Grassland Flowers



USFWS (Retrieved from <https://www.flickr.com/photos/usfwsq/6176383496>)

Fire Frenzy

This packet contains three lessons exploring the role of fire in nature, with human interaction, and includes a townhall meeting in which students will act as stakeholders to debate a fire management plan. Lessons are geared towards grades 9-12.

Fire is a widespread natural process and plays an important role in ecosystems.² Fire existed long before humans and is originally tied to plants, which provides two of the three sources necessary for fire.¹ For a fire to start the conditions have to be just right and must include oxygen, a fuel source, and a heat source. Evidence of the earliest known fire dates back to approximately 440 million years ago.¹ There is some debate about when humans first started using fire, but archaeological evidence suggests that the use of fire occurred sometime between 120,000 and 700,000 years ago.³ Since then, humans have been using fire as a heat source, for cooking, and as a land management tool. Until the late 1800's, humans had to coexist with fire. However, fire became more problematic when more people moved into grasslands and forests, both of which are highly dependent on fire. Humans began to suppress wildfires, which was beneficial at first but resulted in long-term consequences. Fire plays an important role in natural ecosystems, both grassland and forest ecosystems depend on fire to regenerate and clean out dead plants. Each ecosystem has a unique fire regime, which is the pattern, frequency, and intensity of fire that prevail in an area over long periods of time. Fire suppression throughout the grasslands and forests in the United States has led to many negative consequences including more large area of flammable land, invasive species, habitat loss, and more severe fires.

References:

1. Pausa, J.G. & Keeley, J.E. (2009) A Burning Story: The Role of Fire in the History of Life. *BioScience* (59:7). 593-601. <https://doi.org/10.1525/bio.2009.59.7.10>
2. Bond et al. (2005) The Global Distribution of Ecosystems in a World Without Fire. *New Phytologist* (165:2). 525-538. <https://doi.org/10.1111/j.1469-8137.2004.01252.x>
3. Gowlett, J.A. (2016) The Discover of Fire by Humans: A Long and Convolved Process. *Philosophical Transaction of the Royal Society B* (371:1696). <https://doi.org/10.1098/rstb.2015.0164>

Lessons:

1. Human Interactions with Fire:
 - Video about wildfire in Colorado (approximately 30 minutes long) <https://www.youtube.com/watch?v=WbwHRUI87Tk>
 - Short lecture on the history of fire and humans
 - Internet search for news about wildfires
 - Discussion about how fire impacts humans
2. Fire and Nature:
 - Smokey Bear website readings
 - 5-minute group summary on reading reported to class
 - Wildfire diagramming
3. Town Hall Meeting:
 - Stakeholder dilemma about fire management
 - Recap and final discussion

Lesson One: Human Interactions with Fire

Grade/ Grade Band: 9-12	Topic: Environmental Science/ Natural Resources	Lesson # <u>1</u> in a series of <u>3</u> lessons
Brief Lesson Description: Humans have a dynamic relationship with fire. In this lesson, students will explore the relationship between humans and fire.		
Performance Expectation(s): Students will be able to: <ol style="list-style-type: none"> 1. Define wildfire suppression and fire regime 2. Identify how humans have changed the natural fire regime 		
NGSS Standards: SC.HS.7 Interdependent Relationships in Ecosystems SC.HS.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.		
Narrative / Background Information		
Prior Student Knowledge: Basic ecology knowledge Fire is an important, natural process. Grassland and forest ecosystems rely on fire to create regeneration. The natural <u>fire regime</u> of ecosystems varies based on several factors. Humans have always had a complex relationship with fire. Prehistoric humans used fire as a heat source and a land management tool. Until the late 1800's, humans coexisted with fire, but a series of large fires combined with westward movement has resulted in <u>wildfire suppression</u> .		
Science & Engineering Practices: <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	Disciplinary Core Ideas: SC.HS.7.2.E Design, evaluate, and refine a solution for increasing the positive impacts of human activities on the environment and biodiversity.	Crosscutting Concepts: <ul style="list-style-type: none"> • Cause & effect • Patterns
Possible Preconceptions/Misconceptions: Students may not understand how ecosystems and humans can benefit from fire.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Wildfire Video:</u> Student will watch this video showing the impacts that wildfire can have on humans. https://www.youtube.com/watch?v=WbwHRUI87Tk <u>Background Lecture:</u> Provide students with background information in a short lecture. Be sure to cover the background information and prior student knowledge.		
EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i> <ul style="list-style-type: none"> • Paper • Pencil • Computers with internet access Prepare a brief background lecture reviewing ecology basics and the role of nature in an ecosystem <hr/> Wildfire in the News Activity: Students will conduct an internet search for news about wildfire in the United States. Students will choose one article about wildfire to read. Students should summarize the article, reporting on the main points. Each student should share their short summary with the class. The summary should answer the following questions: <ul style="list-style-type: none"> • What news articles did you find about wildfire? • What caused the wildfire? • How long did the fire last? • How did the fire impact humans? • What could have been done to lessen the impacts of the fire? 		

EXPLAIN: Concepts Explained and Vocabulary Defined:

Explain how humans use fire to manage grasslands.
Review lesson vocabulary.

Vocabulary:

- Wildfire suppression- extinguishing or containing a fire from its discovery
- Fire regime- pattern, frequency, and intensity of the bushfires and wildfires that prevail in an area over long periods of time

ELABORATE: Applications and Extensions:

- **Fire Frenzy, Lesson Two:** Fire and Nature
- **Fire Frenzy, Lesson Three:** Town Hall Meeting

EVALUATE:**Formative Monitoring (Questioning / Discussion): Class discussion; article summary**

At the end of the lessons, students will:

- Identify how fire suppression has changed the natural fire regime
- Discuss how humans use fire and the impacts fire has on humans

Elaborate Further / Reflect: Enrichment:

US Wildfire Map: <https://fsapps.nwcg.gov/afm/>

Wildfire Causes and Evaluations: <https://www.nps.gov/articles/wildfire-causes-and-evaluation.htm>

Wildfire Facts: <https://www.dosomething.org/us/facts/11-facts-about-wildfires>

NatGeo Wildfire video: <https://www.youtube.com/watch?v=5hghT1W33cY>

Grassland Fire Ecology: <https://www.nps.gov/articles/grassland-fire-brief.htm>

Lesson Two: Fire and Nature

Grade/ Grade Band: 9-12	Topic: Environmental Science/ Natural Resources	Lesson # 2 in a series of 3 lessons
Brief Lesson Description: Fire is a natural part of many ecosystems. In this lesson, students will explore the role that fire plays in nature.		
Performance Expectation(s): Students will be able to: <ol style="list-style-type: none"> 1. Discuss the role of fire in nature 2. Identify factors influencing the natural fire regime of an ecosystem 		
NGSS Standards: SC.HS.7 Interdependent Relationships in Ecosystems SC.HS.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.		
Narrative / Background Information		
Prior Student Knowledge: Basic ecology knowledge Fire is an important, natural process. Grassland and forest ecosystems rely on fire to create regeneration. The natural <u>fire regime</u> of ecosystems varies based on several factors. Each ecosystem has a unique fire regime, which is the pattern, frequency, and intensity of fire that prevail in an area over long periods of time. <u>Wildfire suppression</u> throughout the grasslands and forests in the United States has led to many negative consequences including more large area of flammable land, invasive species, habitat loss, and more severe fires.		
Science & Engineering Practices: <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	Disciplinary Core Ideas: SC.HS.7.2.C Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	Crosscutting Concepts: <ul style="list-style-type: none"> • Cause & effect • Patterns
Possible Preconceptions/Misconceptions: Students may have a fear or misunderstanding of wildfire.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: Wildfire Readings: Students should read the ‘About Wildfire’ section from smokeybear.com (https://smokeybear.com/en/about-wildland-fire). After students finish reading the first section, break into pairs. Assign each student group one of the following readings from smokeybear.com <ul style="list-style-type: none"> • Benefits of Fire (https://smokeybear.com/en/about-wildland-fire/benefits-of-fire) • Fire in Nature (https://smokeybear.com/en/about-wildland-fire/benefits-of-fire/fire-in-nature) • Fire-Dependent Ecosystem with Periodic Fire/Fire-Dependent Ecosystem without Periodic Fire (https://smokeybear.com/en/about-wildland-fire/benefits-of-fire/fire-in-nature/fire-dependent-ecosystem-with-periodic-fire ; https://smokeybear.com/en/about-wildland-fire/benefits-of-fire/fire-in-nature/fire-dependent-ecosystem-without-periodic-fire) • Fire Science/Elements of Fire (https://smokeybear.com/en/about-wildland-fire/fire-science ; https://smokeybear.com/en/about-wildland-fire/fire-science/elements-of-fire) Five Minute Report: Students should take notes on the main points of the article and prepare a five-minute report. After all groups have finished, each pair will present their five-minute report to the class. Students should answer the following questions during their report: <ul style="list-style-type: none"> • Why is fire important to nature? • How can fire be used by humans as a land management technique? • How can humans be prepared for wildfire? What steps can we take to lessen the impact of fire on our communities? 		
EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: Lesson Materials & Preparations: <ul style="list-style-type: none"> • Computer to access readings • Paper • Pencil • Colored pencils/ markers <hr/> Role of Fire Diagramming: Students will diagram the role fire plays in nature using information gained from readings. Students should work individually and use external resources as needed. The diagram should include the following:		

- Pictures
- Causes & effects
- Impacts of ecosystem components
- Impacts on animals
- Impacts on human

EXPLAIN: Concepts Explained and Vocabulary Defined:

Explain concept of fire regime and return interval.
 Explain the importance of fire to certain ecosystems
 Review lesson vocabulary.

Vocabulary:

Ecosystem- a community of living organisms, non-living components, and the physical environment

Fire regime- pattern, frequency, and intensity of the bushfires and wildfires that prevail in an area over long periods of time

ELABORATE: Applications and Extensions:

- **Fire Frenzy, Lesson Three: Town Hall Meeting**

EVALUATE:

Summative Assessment (Quiz / Project / Report): Five-minute report; Wildfire diagram

At the end of the lesson, students will:

- Identify the role of fire in nature
- Discuss how fire impacts plants, animals, and humans

Elaborate Further / Reflect: Enrichment:

Animals in Wildfire: <https://www.nationalgeographic.com/news/2014/7/140721-animals-wildlife-wildfires-nation-forests-science/>

Wildfire and Ecosystems: <https://www.fs.usda.gov/pnw/page/fire-effects-environment>

Wildfire Effects on Flora: https://www.fs.fed.us/rm/pubs/rmrs_gtr042_2.pdf

Restoring Fire in Grasslands: <https://www.nature.org/en-us/about-us/where-we-work/united-states/minnesota/stories-in-minnesota/restoring-fire-to-native-grasslands/>

Lesson Three: Town Hall Meeting

Grade/ Grade Band: 9-12	Topic: Natural Resources/Environmental Science	Lesson # 3 in a series of 3 lessons
<p>Brief Lesson Description: Fire and prescribed burning is a beneficial part of grassland ecosystems but can be a polarizing topic. In this lesson, students will participate in a town hall meeting to explore the different components of fire.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Discuss the role of fire in nature 2. Discuss human dimensions of fire management 3. Provide a solution to the complex issue of fire management 		
<p>NGSS Standards: SC.HS.15 Sustainability SC.HS.15.5 Gather, analyze, and communicate evidence to describe the interactions between society, environment, and economy.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic communication skills; ecosystem knowledge; basic fire ecology knowledge</p> <p>The relationship between humans and fire is long and complex. Fire can be used as a valuable land management technique. Many public land management agencies use prescribed burns as a method to reduce flammable dead plant matter. Landowners, public land managers, and the general public often collaborate to work on natural resource management issues. These <u>stakeholders</u> play an important role in the decision-making process.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	<p>Disciplinary Core Ideas: SC.HS.15.5.E Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Cause & effect • Patterns
<p>Possible Preconceptions/Misconceptions: Students may not think fire can be used positively.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Class Discussion:</u> Open with a class discussion to review previous materials. Lead discussion with the following questions:</p> <ul style="list-style-type: none"> • What role does fire play in an ecosystem? • How have humans changed that role? • How can fire be used as a management technique? • What ecosystems depend on fire? 		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> • Dilemma and stakeholder cards • Paper • Pencil <p>Print out enough stakeholder and dilemma cards for each student</p>		
<p><u>Town Hall Meeting:</u> Divide students into groups of four, pass out one stakeholder card to each student and one dilemma card to each group. Allow approximately 20 minutes for groups to work through dilemma. After finishing, each group should summarize their thoughts to share with the class.</p>		
<p><u>Wrap up Discussion:</u> After completing all lessons and activities, lead a final class discussion. Lead a class discussion with the following questions:</p> <ul style="list-style-type: none"> • After completing these activities, what do you know about fire? 		

- How do humans use fire?
- How are humans impacted by fire?
- What is a fire regime?
- What is wildfire suppression? What are the results of wildfire suppression?

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any additional questions from class.

Review the role of fire in an ecosystem.

Discuss Possible outcomes of continued fire suppression.

Review lesson vocabulary.

Vocabulary:

Fire regime- pattern, frequency, and intensity of the bushfires and wildfires that prevail in an area over long periods of time

Wildfire suppression- extinguishing or containing a fire from its discovery

Stakeholder- a person with an interest or concern in some matter

Natural resource- materials or substances that occur in nature

ELABORATE: Applications and Extensions:

- **Anthroposphere, Human Dimensions of the Grasslands**
- **Biosphere, Eastern Redcedar Invasions in Grassland Systems**

EVALUATE:

Formative Monitoring (Questioning / Discussion): Town Hall Meeting; class discussion

At the end of the lesson, students will:

- Discuss the role of fire in an ecosystem
- Identify how fire can be used as a management tool.

Additional Resources:

Stakeholders: <https://resourcegovernance.org/approach/stakeholders>

Stakeholder Identification video: <https://www.youtube.com/watch?v=8uZiGB8DeJg>

Town Hall Meeting Materials:

Dilemma:

A large area of grassland near the town of Big Bluestem is overgrown with dead grass and trees. The area is highly flammable and unsightly but provides excellent habitat for native birds and wildlife. Many of the residents of Big Bluestem frequent the grassland for hunting and outdoor recreation. Other residents of Big Bluestem believe the area is an eyesore and complain that it needs to be removed.

Stakeholders:

- **Resident of Big Bluestem**- You think the grassland is an eyesore and would like to see it burned to remove the dead trees and grass. However, the reduced air quality is a major concern because you suffer from asthma and won't be able to handle poor air quality.
- **Grassland Manager**- You would like to do a controlled burn on this area of land to reduce the dead grass and trees. Doing a controlled burn would reduce the flammability of the area and help the grasslands regenerate. However, it would result in a loss of habitat for bird and wildlife. The controlled burn would also temporarily reduce the air quality in the town of Big Bluestem.
- **Wildlife Biologist**- You would like to leave the area alone because it is home to native bird and other wildlife. Doing a controlled burn would reduce the number of dead trees that many birds use for nesting areas. Additionally, the hunters that use the grassland provide revenue to the area.
- **Bird Hunter**- You would like to leave the area alone because it is great for bird hunting. The grassland is close to your home and you enjoy frequenting the area for outdoor recreation. You pay money when you hunt so it should be left as is.

Great Plains Oral History

This packet contains two lessons to explore how communities in the Great Plains have changed by interviewing older members of the community. Students will engage in an open discussion about how the natural landscape and social dynamics of their local community have changed. Lessons are geared towards grades 9-12.

The Great Plains is a geographical region located between the Rocky Mountains on the west and the Mississippi River on the East, this region stretches from the Canada border to the Mexico border. Historically, the Great Plains was composed of large open swaths of grassland mixed with some wooded outcroppings. However today, much of land in the Great Plains is in agricultural production and relies heavily on natural resources. Additionally, as the human population grows, much of the undeveloped land or farmland is being converted to urban land. It is important to recognize land use changes as the human population continues to grow and developed areas continue to expand. Between 1973 and 2000, developed land in the Great Plains increased from 1.1 percent to 1.5 percent. At the same time, land in agricultural use declined from 46 percent to 43.8 percent. While this may not seem like an alarming trend, it is important to consider the increasing human population. Between 1970 and 2000, the human population of the Great Plains increased from approximately 6 million to 9 million. To understand how these changes impacted communities, we can discuss land use changes with older generations. People of have lived in this region for more than 30 years may be able to convey changes they've seen in their community and the land.

References:

1. Acevedo, W., Auch, R.F, Brooks, M.S., Drummond, M.A., Friesen, B.A., Kambly, S., Karstensen, K.A., Rich, C.L., Sayler, K.L., Stier, M.P, Taylor, J.L. (2015) Land-Cover Trends in the Great Plains of the United States—1973 to 2000. Edited by Taylor, J.L., Acevedo, W., Auch, R.F, and Dummond, M.A. U.S. Geological Survey Professional Paper 1794—B. Retrieved from: <https://pubs.usgs.gov/pp/1794/b/pp1794b.pdf>
2. Wilson, S.G. (2009) Population Dynamics of the Great Plains: 1950 to 2007, Population Estimates and Projections. U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau. Retrieved from: <https://www.census.gov/prod/2009pubs/p25-1137.pdf>

Lessons:

1. Community Background:
 - Background lecture and discussion on environmental changes in the Great Plains
 - Community changes mind mapping session—students will create a mind map of the changes they've seen
 - Interview subject brainstorming session—students will compile a list of potential interview subjects
2. Land Talk Interview and Report:
 - Land Talk conversations—students will explore the Land Talk website and listen to a few recorded conversations
 - Background lecture on how to conduct an interview and review of interview questions
 - Land Talk Interview and Report—students will conduct the interview, then write a report on their interview subject

Lesson One: Community Background

Grade/ Grade Band: 9-12	Topic: Natural Resources/ Environmental Science	Lesson # 1 in a series of 2 lessons
<p>Brief Lesson Description: In this lesson, students will research background information about their community and brainstorm a list of family or community members to serve as potential interview subjects.</p>		
<p>Performance Expectation(s): At the end of the lesson, students will be able to:</p> <ol style="list-style-type: none"> 1. Analyze interviews and examine the culture of the Great Plains 2. Identify environmental, cultural, and social changes within their community 3. Reflect on the social, cultural, and environmental changes in the Great Plains 		
<p>NGSS Standards: SC.HS.15 Sustainability SC.HS.15.5 Gather, analyze, and communicate evidence to describe the interactions between society, environment, and economy.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic communication skills, interview skills, basic natural resource background and vocabulary Historically, the <u>Great Plains</u> was composed of large open swaths of grassland mixed with some wooded outcroppings. However today, much of land in the Great Plains is in agricultural production and relies heavily on <u>natural resources</u>. Additionally, as the human population grows, much of the undeveloped land or farmland is being converted to urban land. It is important to recognize <u>land use</u> changes as the human population continues to grow and developed areas continue to expand.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Asking Questions & Defining Problems • Planning & Carrying Out Investigations 	<p>Disciplinary Core Ideas: SC.HS.15.5.A Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Cause and Effect • Stability and Change
<p>Possible Preconceptions/Misconceptions: Students may not think or know about how much the Great Plains has changed over the past century. Students may not understand how knowledge can be obtained from talking to older generations, or how that knowledge relates to natural resources.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <i>Lesson Materials & Preparations</i></p> <ul style="list-style-type: none"> • Computers with internet access • Paper • Pencil • Auto/video recording device (students can use their smart phones or computers) <p>Prepare a brief background lecture reviewing basic environmental science vocabulary and discussing environmental changes in the Great Plains.</p>		
<p>Background Lecture & Discussion: Provide students with background information on environmental changes in the Great Plains. Review basic environmental science vocabulary. Include thought provoking discussion questions to generation interest. Use the following questions to guide discussion:</p> <ul style="list-style-type: none"> • What do you like about the natural environmental where you live? • How do people in your community make their living? • What tourism or recreational activities are important to the community? • What environmental changes have you seen in your lifetime? • What concerns do you have about changes to the environment? • What environmental changes have your parents or grandparents talked about? • What can we learn by talking to older generations? • How can we apply the knowledge learned from talking to older generations? 		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <u>Community Changes Mind Map Session:</u> Students will brainstorm a list of environmental changes they have seen in their lifetime and create a mind map of their thoughts and ideas. The purpose of this activity is to get students to think critically about the changes they've seen and changes that have occurred in the past. Students should think about how life on the Great Plains has changed and impacted inhabitants.</p> <p><u>Interviewee Brainstorming Session:</u> Students will brainstorm a list of possible interview subjects. Ideally, the subject should be someone</p>		

that has lived in the Great Plains for more than 30 years. Good interview subjects should be someone willing to discuss their childhood, life growing up, and the changes they have seen in the Great Plains. Examples of good interview subjects are relatives such as aunts, uncles, or grandparents or community members such as neighbors, family friends, individuals from your church or social club, etc.

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Explain how to ask interview questions.

Explain what can be learned by interviewing older community members.

Review lesson vocabulary.

Vocabulary:

Great Plains- a prairie landscape region between the Rocky Mountains and the Mississippi River

Land Use- the human use of land representing economic and cultural activity

Natural Resources- materials or substances that occur in nature and exist without actions from humans

ELABORATE: Applications and Extensions:

- **Land Talk, Lesson Two:** Land talk Interview and Report

EVALUATE:

Formative Monitoring (Questioning / Discussion): Class Discussion/Mind Map

Students will be able to:

- Identify potential interview subjects
- Described environmental changes in the Great Plains
- Identify the driving factors influencing environmental changes in the Great Plains

Additional Resources:

Land Talk Website: <https://landtalk.stanford.edu>

How to conduct an interview: <https://legacyproject.org/guides/lifeinttips.html>

Stakeholder identification video: <https://www.youtube.com/watch?v=8uZiGB8DeJg>

EPA land use: <https://www.epa.gov/report-environment/land-use#definition>

Lesson Two: Land Talk Interview and Report

Grade/ Grade Band: 9-12	Topic: Natural Resources/ Environmental Science	Lesson # 2 in a series of 2 lessons
<p>Brief Lesson Description: In this lesson, students will practice communication and interview skills, conduct an interview with an older community member, and report on their interview subject.</p>		
<p>Performance Expectation(s): At the end of the lesson, students will be able to:</p> <ol style="list-style-type: none"> 1. Analyze interviews and examine the culture of the Great Plains 2. Identify environmental, cultural, and social changes within their community 3. Reflect on the social, cultural, and environmental changes in the Great Plains 		
<p>NGSS Standards: SC.HS.15 Sustainability SC.HS.15.5 Gather, analyze, and communicate evidence to describe the interactions between society, environment, and economy.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic communication skills, interview skills, basic natural resource background and vocabulary Historically, the <u>Great Plains</u> was composed of large open swaths of grassland mixed with some wooded outcroppings. However today, much of land in the Great Plains is in agricultural production and relies heavily on <u>natural resources</u>. Additionally, as the human population grows, much of the undeveloped land or farmland is being converted to urban land. It is important to recognize <u>land use</u> changes as the human population continues to grow and developed areas continue to expand. Talking with older members of a community can provide valuable knowledge about how the environmental and social components of an area have changed over time.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Asking Questions & Defining Problems • Planning & Carrying Out Investigations 	<p>Disciplinary Core Ideas: SC.HS.15.5.A Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Cause and Effect • Stability and Change
<p>Possible Preconceptions/Misconceptions: Students may not think or know about how much the Great Plains has changed over the past century. Students may not understand how knowledge can be obtained from talking to older generations, or how that knowledge relates to natural resources.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <i>Lesson Materials & Preparations</i></p> <ul style="list-style-type: none"> • Computers with internet access • Paper • Pencil • Auto/video recording device (students can use their smart phones or computers) • Interview question student handout <p>Prepare a brief background lecture reviewing the basics of interview a subject and the Land Talk submission guidelines. Print out the interview question handout for students.</p>		
<p><u>Land Talk Conservations:</u> Students will explore the Land Talk website and choose one or two conservations to listen to. Students should try to choose conservations local to their hometown if available.</p>		
<p><u>Background Lecture:</u> Provide students will background information on how to conduct an interview and review the Land Talk submission guidelines. https://landtalk.stanford.edu/guidelines/</p>		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <u>Interview Question Review:</u> Students review the interview questions provided in the student handout. Students can be divided into pairs to practice reading and answering the interview questions. Students may have questions about the format of the interview questions—explain how to read the questions.</p> <p><u>Land Talk Interview:</u> Students will use the questions on the handout to conduct an interview with the interview subject of their choice. With permission, students should record the interview.</p> <p><u>Land Talk Report:</u> Following the interview, students will create a report on the interview process, the subject, and the environmental changes discussed. Students can use any format, such as an essay, PowerPoint, or oral presentation.</p>		

The report should include the following:

- Photo of the Interviewee
- Photo of the town or area discussed
- Background on the interviewee
- Interview methods
- Important childhood/family events
- Important cultural events
- Important environmental events
- Important social events
- Changes to the community over at least 30 years
- Environmental changes over at least 30 years
- Reflection
- Conclusion
- Transcript of the interview

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Explain how to ask interview questions.

Explain what can be learned by interviewing older community members.

Review lesson vocabulary.

Vocabulary:

Great Plains- a prairie landscape region between the Rocky Mountains and the Mississippi River

Land Use- the human use of land representing economic and cultural activity

Natural Resources- materials or substances that occur in nature and exist without actions from humans

Human Dimensions- in natural resources, the human knowledge and attitude factors that affect how natural resources are managed

ELABORATE: Applications and Extensions:

EVALUATE:

Summative Assessment (Project): Land Talk Report

Students will be able to:

- Submit an interview report
- Think critically about environmental changes to the Great Plains
- Identify driving factors of environmental changes in the Great Plains

Additional Resources:

Land Talk Website: <https://landtalk.stanford.edu>

How to conduct an interview: <https://legacyproject.org/guides/lifeinttips.html>

Stakeholder identification video: <https://www.youtube.com/watch?v=8uZiGB8DeJg>

EPA land use: <https://www.epa.gov/report-environment/land-use#definition>

Great Plains Encyclopedia: <https://www.britannica.com/place/Great-Plains>

Student Interview Questions

Questions are designed to go from least specific to most specific—if the informant already answers one question before you ask it, you **do not** need to ask it again. If you'd like the informant to go into more detail, ask them to go into more detail or ask them a relevant question to get them talking.

Interview questions:

1. How old are you?
2. Where are you from?
 - a. How long have you lived in this community?
 - b. Did you grow up in this community?
3. Can you describe what the area you grew up in looked like?
 - a. What did your town look like?
 - b. What did your home look like?
 - c. What did the natural environment look like?
4. How long have you lived in the Great Plains?
 - a. How long has your family lived in the Great Plains?
 - b. Do you have any family history of homesteading?
5. Can you describe your childhood living in the Great Plains?
 - a. What did you do as a child?
 - b. What was your family life like?
 - c. What did you want to be when you grew up?
 - d. What was your school like?
 - e. What was your first job?
6. What do/did you do for a living?
 - a. How did you get into your line of work?
 - b. What lessons did you learn from your work?
7. Can you describe the culture of the area you grew up in?
 - a. What cultural changes can you recall?
 - b. How do you think the culture impacted your life?
 - c. Can you describe your experience during a war?
 - i. Did you go to war?
 - ii. How was your community impacted by war?
 - d. Can you describe your experience during the Great Depression?
 - i. How was your family impacted by the Depression?
 - ii. How was your Community impacted by the Depression?
 - e. How would you describe the culture of the area now?
8. What social changes can you recall?
 - a. Can you describe what you and your family did for fun?
 - b. Were you or your family part of a social club?
 - i. What was the primary function of the club?
 - c. Did you attend a church?
 - i. How far was the church from your home?
 - d. Can you recall any racial or political changes in your community?
 - i. If so, how did the community respond to those changes?
9. Can you describe the general climate and weather of the area you grew up in?
 - a. How would you describe the winters and summers during your childhood?
 - i. What was a normal winter?
 - ii. What was a normal summer?
 - b. Did you or your family experience the dust bowl?
 - i. If so, how was your family impacted by the dustbowl?

- ii. What changes occurred after the dustbowl?
 - c. Can you recall any major natural disasters?
 - i. How was your family impacted by a natural disaster?
 - ii. How was your community impacted by a natural disaster?
 - iii. Did you or your community do anything to prepare for natural disasters?
 - d. What changes to the climate and weather patterns have you noticed from your childhood to now?
- 10. What changes to your community have you seen from your childhood to now?
 - a. Can you describe this place when you were a child?
 - b. Can you describe this place now?
 - c. Why did those changes occur?
 - d. How has the natural environment changed?
 - e. Can you describe your experience with the change?
- 11. Is there anything else you would like to share about your experience living on the Great Plains?

Optional Questions:

Social:

1. How did you and your family spend your weekend?
 - a. Were you allowed to work or play on a Sunday?
 - b. Did religion play a major role in your childhood?
 - i. Can you talk more about your experience with religion?
2. Did you or your family experience any disease epidemics?
 - a. If so, can you describe that event?
3. What kind of clothing did you wear?
 - a. Where did you get your clothing?
4. What did you do in your spare time?
 - a. Did you spend time with a specific group of friends?
 - b. What did you do with your friends?
 - c. How would you describe a good night out with friends?
5. How did you meet your partner?
 - a. Why did you decide to get married?
 - i. Did you have a religious or civil ceremony?
 - b. How would describe your relationship?

Cultural:

1. How have some historical events affected you, your family, or your community?
 - a. What historical events affected you?
2. What community traditions did your community celebrate when you were a child?
 - a. What community traditions does your community celebrate today?
3. What foods did you eat growing up?
 - a. Did you eat any cultural foods?
 - i. If so, what types of cultural foods did you eat?
 - b. Did your family grow most of its own food?
 - c. How often did your family eat out at a restaurant?
4. Did your family having running water, electricity, and phone during your childhood?
 - a. Do you recall anyone in your community not having running water, electricity, or phone?
 - b. When did your family get running water, electricity, and phone?

Environmental:

1. What land use changes have you witnessed throughout your life?
 - a. How has land use changed from your childhood to now?
2. When you were a child, did you or your family think about how much water you used?
 - a. How did you and your family use water?
 - b. Can you recall where your water came from?
3. Do you feel that you and your family were connected to the land?
 - a. How did your family use the land?
 - b. Did you spend time in nature?

Report Template

1. Introduction- introduce the individual and their background. Set up the rest of the report by introducing what you plan to write about
2. Historic and Current Photo
 - a. Include a historic photo of the community your informant discusses Include a current photo of the community
3. Methods- Describe the method you used to interview the subject
 - a. When, where, and how you conducted the interview
 - b. How long the interview lasted
 - c. How you recorded the interview—digital, video, written, etc.
 - d. Include the questions asked
4. Important Childhood/Family Events- describe any notable events or characteristics of childhood
 - a. Focus on events that exemplify childhood on the Great Plains
5. Important Cultural Events- describe notable events or cultural characteristics of the informant's life
 - a. Significant cultural events (war, civil rights, etc.)
 - b. Specific culture of the area
6. Important Social Events- describe notable social interactions or events of the informant's life
 - a. Leisure activities
 - b. Church/religion
 - c. Social organizations
 - d. Political or social changes in the community
7. Important Environmental Events- describe notable environmental events
 - a. Natural disaster
 - b. Major environmental changes from childhood to now
 - c. Land use changes
8. Changes to the Community Over 30 Years- describe how the community changed over 30 years
 - a. What does the place mean to the informant?
 - b. What was the experience of the informant?
 - c. How has it changed?
 - d. Why has it changed?
9. Reflection- Reflect on what life in the Great Plains was like and what it meant to your informant
 - a. How did their life influence their views, beliefs, culture, values, identity, etc.
10. Conclusion- Summarize what you learned through the whole interview process
 - a. Contrast your life experience to that of your informant
 - b. Highlight similarities and differences
 - c. How has this impacted your thoughts and views of life on the Great Plains?
 - d. What would you have done differently?

Atmosphere

A landscape photograph at sunset or sunrise. The sky is a gradient of light blue at the top, transitioning to a warm orange and yellow near the horizon. In the foreground, there are dark silhouettes of mountains and a prominent windmill structure. The word "Atmosphere" is overlaid in large, bold, black text across the center of the image.

Atmosphere

This packet contains two sections with five lessons to investigate the atmospheric interactions in the Grasslands of the United States.

The Atmosphere is the gaseous envelope that surrounds the Earth and acts as a protective barrier. The chemical composition of the atmosphere makes for hospitable conditions, allowing life to exist on Earth. The Atmosphere is primarily composed of nitrogen, oxygen, carbon dioxide, argon, and neon. There are a number of special processes that occur within the atmosphere that also contribute to the hospitable conditions. The greenhouse effect helps to regulate temperature and insulate the Earth. However, anthropogenic climate change has resulted in more greenhouse gases, such as carbon dioxide, being added to the Atmosphere. It is important to understand how matter and energy cycle through all of Earth's sphere to combat climate change and manage natural resources. These lessons will specifically look at how the grasslands in the United States are connected to the greenhouse effect and the carbon cycle.

Sections:

1. Exploring Earth's Atmosphere
 - Atmosphere Diagramming
 - Greenhouse Effect
 - Matter and Energy Interactions in the Grasslands
2. Weather and Climate
 - Weather and Climate
 - Paleoclimate

Exploring Earth's Atmosphere

This section contains three lessons that explore the Earth's atmosphere by conducting research and creating models of the atmosphere and carbon cycle. Lessons are geared towards grades 9-12.

The Earth's atmosphere acts as a protective barrier and provides many important benefits. The atmosphere is a gaseous bubble composed of nitrogen, oxygen, carbon dioxide, argon, and neon.¹ The chemical composition makes for hospitable conditions allowing life to exist on Earth. Processes, such as the greenhouse effect, help to regulate temperature and insulate the Earth.³ The atmosphere is made up of different layers, each with different conditions, some of which influence wind currents and weather patterns.²

References:

1. Earth's Atmosphere. UCAR Center for Science Education. Retrieved from: <https://scied.ucar.edu/shortcontent/earths-atmosphere>
2. Zell, H. (2013). Earth's Atmospheric Layers. Earth. NASA. Retrieved from: https://www.nasa.gov/mission_pages/sunearth/science/atmosphere-layers2.html
3. The Greenhouse Effect. UCAR Center for Science Education. Retrieved from: <https://scied.ucar.edu/longcontent/greenhouse-effect>

Lessons:

1. Atmosphere Diagramming:
 - Earth's Atmosphere video—Students will watch a short video on the layers of Earth's atmosphere
 - Atmosphere Diagram—Students will conduct background research, then construct a diagram of Earth's atmosphere
2. Greenhouse Effect:
 - Background Lecture—Students will review information learned in lesson one
 - Blanket Demonstration—Students will participate in a demonstration of the greenhouse effect using the heat from their bodies and a blanket
 - Research Paper—students will conduct background research, then write a 3-page paper on the greenhouse effect
3. Matter and Energy Interactions in the Grasslands:
 - Carbon Cycle video—Students will watch a short video on the carbon cycle
 - Carbon Cycle Diagram—students will conduct background research, then construct a diagram of carbon cycling in a grassland ecosystem
 - Class Discussion—Students will participate in a class discussion to wrap up the lesson

Lesson One: Atmosphere Diagramming

Grade/ Grade Band: 9-12	Topic: Earth Science	Lesson # 1 in a series of 3 lessons
<p>Brief Lesson Description: In this lesson, students will explore the different layers of the atmosphere and create a diagram of the atmosphere.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Construct a diagram representing the layers of Earth’s atmosphere and their function 2. Explain how the sun’s energy moved through Earth’s atmosphere 		
<p>NGSS Standards: SC.HS.12 Weather and Climate SC.HS.12.2 Gather, analyze, and communicate evidence to support that Earth's climate and weather are influenced by energy flow through Earth systems.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic earth science background; This lesson provides background information on Earth’s atmosphere Earth’s <u>atmosphere</u> acts as a protective barrier between the planet and space. The atmosphere is composed of a number of different gases that help to make the Earth a habitable planet.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	<p>Disciplinary Core Ideas: SC.HS.12.2.A Construct an explanation based on evidence for how the sun’s energy moves among Earth’s systems.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Patterns • Cause & effect • Chemistry
<p>Possible Preconceptions/Misconceptions: Students may not know that the atmosphere is composed of several different layers. Students may not know how the atmosphere influences weather conditions.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Earth’s Atmosphere video:</u> Students will watch this National Geographic video on Earth’s atmosphere https://www.youtube.com/watch?v=1YAOT92wuD8</p> <p><u>Background Research-</u> Students will conduct an internet search to learn more about the atmosphere. Students should start with the following sources from NASA and find additional sources as needed. NASA Atmosphere resources: https://spaceplace.nasa.gov/atmosphere/en/ https://climate.nasa.gov/news/2919/earths-atmosphere-a-multi-layered-cake/</p>		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> • Computers with internet access • Paper • Pencil • Colored Pencils/Markers <hr/> <p><u>Atmosphere Diagramming-</u> Students will research the layers of the Earth’s atmosphere and create a diagram of the layers. Each layer should be represented along with an explanation of its function. The following layers should be included:</p> <ul style="list-style-type: none"> • Troposphere • Stratosphere • Mesosphere • Thermosphere • Ionosphere • Exosphere <p>Other components that should be included:</p> <ul style="list-style-type: none"> • The Sun • Layer distance from Earth • Weather conditions in each layer 		

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Explain the role of Earth's atmosphere.

Review lesson vocabulary.

Vocabulary:

Atmosphere- Envelope of gases surrounding the Earth

ELABORATE: Applications and Extensions:

- **Exploring Earth's Atmosphere, Lesson Two:** Greenhouse Effect
- **Exploring Earth's Atmosphere, Lesson Three:** Matter and Energy Interactions in the Grasslands

EVALUATE:**Summative Assessment (Quiz / Project / Report): Atmosphere Diagram**

At the end of the lesson, students will be able to:

1. Submit an atmosphere diagram
2. Demonstrate knowledge of atmosphere function
3. Explain how the Sun's energy moves through the atmosphere

Elaborate Further / Reflect: Enrichment:

Atmospheric Layers- <https://climate.nasa.gov/news/2919/earths-atmosphere-a-multi-layered-cake/>

Human Impact on the Atmosphere- <https://climate.nasa.gov/news/2914/the-atmosphere-earths-security-blanket/>

NASA's Role in Studying the Atmosphere- <https://climate.nasa.gov/news/2921/nasas-role-in-studying-earths-atmosphere/>

Lesson Two: Greenhouse Effect

Grade/ Grade Band: 9-12	Topic: Earth Science	Lesson # 2 in a series of 3 lessons
<p>Brief Lesson Description: In this lesson, students will explore the greenhouse effect and the role that grassland ecosystems play in the carbon cycle.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Explain how the greenhouse gas effect works 2. Describe the role of the greenhouse gas effect in Earth’s atmosphere 		
<p>NGSS Standards: SC.HS.12 Weather and Climate SC.HS.12.2 Gather, analyze, and communicate evidence to support that Earth's climate and weather are influenced by energy flow through Earth systems.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic earth science background; Background from Exploring Earth’s atmosphere lessons one</p> <p>Earth’s <u>atmosphere</u> acts as a protective barrier between the planet and space. The atmosphere is composed of a number of different gases that help to make the Earth a habitable planet. Some gases in the atmosphere trap heat to create a <u>greenhouse effect</u>, which helps to keep the planet warm. However, too much of certain gases can lead to excess heat being trapped.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	<p>Disciplinary Core Ideas: SC.HS.12.2.A Construct an explanation based on evidence for how the sun’s energy moves among Earth’s systems.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Patterns • Cause & effect • Chemistry • Biology
<p>Possible Preconceptions/Misconceptions: Students may not know what the greenhouse effect is. Students likely won’t know that the greenhouse effect is responsible for keeping the Earth warm.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Background Lecture</u>- Review information learned in Lesson One: Atmosphere Diagram. Explain to the class that the greenhouse effect is a naturally occurring process that helps to keep the Earth at a livable temperature.</p> <p><u>Blanket Demonstration</u>- Wrap each student in a blanket to demonstrate how heat is trapped by the atmosphere. The blanket, similar to the atmosphere, traps heat in and our bodies radiate heat, similar to the Earth. Optional, wrap an additional blanket to demonstrate the addition of gases to the atmosphere. Lead a discussion with the following questions:</p> <ul style="list-style-type: none"> • What does the blanket represent in this demonstration? • What do you represent in this demonstration? • What happened when we added additional blankets? • What do additional blankets represent? • How do humans contribute to the greenhouse effect? <p><u>Greenhouse Effect video</u>- Show the following video on how greenhouse gases work. https://www.youtube.com/watch?v=sTvqlijvTg</p>		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> • Blankets • Computers with internet access • Paper • Pencil <hr/> <p><u>Background Research</u>- Students will conduct an internet search to learn more about the greenhouse effect, look at models and diagrams, and find resources.</p> <p><u>Greenhouse Effect Research Paper</u>- Students will write a 3-page paper using the information found during their background research.</p>		

Students should discuss the role of the greenhouse effect, tying together information learned in lesson one. Students can use the resources provided in the additional resources section as a starting point.

The research paper should include the following criteria:

- Role of the greenhouse effect
- Diagram of the greenhouse effect
- Human influence
- Description of the steps of the greenhouse effect
- References

*Option extension activity:

Use a seed starter kit to demonstrate the greenhouse effect on a small scale. The plastic dome represents the atmosphere, trapping heat and moisture. This is an excellent hands-on demonstration for students to visualize the process.

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Explain that the greenhouse effect is an important, natural process.

Review lesson vocabulary.

Vocabulary:

Atmosphere- Envelope of gases surrounding the Earth

Greenhouse effect- Natural process that traps heat from the sun in the lower atmosphere due to the concentration of gases in the atmosphere

Carbon cycle- A biogeochemical cycle in which carbon is exchanged among the biosphere, hydrosphere, atmosphere, and geosphere

Carbon sequestration- Natural process in which carbon dioxide is removed from the atmosphere and held in solid or liquid form

ELABORATE: Applications and Extensions:

- **Exploring Earth's Atmosphere, Lesson Three:** Matter and Energy Interactions in the Grasslands

EVALUATE:

Summative Assessment (Report): Greenhouse Effect Research Paper

At the end of the lesson, students will be able to:

1. Submit a 3-page research paper on the greenhouse effect
2. Explain how the greenhouse effect works
3. Identify the role humans play in the greenhouse effect

Elaborate Further / Reflect: Enrichment:

NASA Greenhouse Effect video- <https://www.jpl.nasa.gov/edu/learn/video/nasas-earth-minute-gas-problem/>

Greenhouse Effect- <https://www.environment.gov.au/climate-change/climate-science-data/climate-science/greenhouse-effect>

Greenhouse Effect- <https://scied.ucar.edu/longcontent/greenhouse-effect>

NASA Earth's Vital Signs- <https://climate.nasa.gov>

Carbon Sequestration- https://www.usgs.gov/faqs/what-carbon-sequestration?qt-news_science_products=0#qt-news_science_products

Lesson Three: Matter and Energy Interactions in the Grasslands

Grade/ Grade Band: 9-12	Topic: Earth Science	Lesson # 3 in a series of 3 lesson
<p>Brief Lesson Description: In this lesson, students will explore matter and energy exchange by looking at the carbon cycles in a grassland ecosystem.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Demonstrate matter and energy exchanges using the carbon cycle in a grassland ecosystem 2. Explain the role of energy from the sun in the relationship between the atmosphere, hydrosphere, biosphere, and geosphere 		
<p>NGSS Standards: SC.HS.8 Matter and Energy in Organisms and Ecosystems SC.HS.8.3 Gather, analyze, and communicate evidence of the flow of energy and cycling of matter in organisms and ecosystems.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic earth science background; Basic carbon cycle background; Background information from lessons one and two</p> <p>Earth's <u>atmosphere</u> acts as a protective barrier between the planet and space. The atmosphere is composed of a number of different gases that help to make the Earth a habitable planet. Some gases in the atmosphere trap heat to create a <u>greenhouse effect</u>, which helps to keep the planet warm. However, too much of certain gases can lead to excess heat being trapped. One such gas, carbon dioxide, is essential to life on Earth and is continually cycled through a process called the <u>carbon cycle</u>. Grasslands act as a <u>carbon sink</u>, storing large amounts of carbon in belowground biomass.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	<p>Disciplinary Core Ideas: C.HS.8.3.F Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Patterns • Cause & effect • Chemistry • Biology
<p>Possible Preconceptions/Misconceptions: Students may not know much about the carbon cycle, or that carbon is an essential element to all life on earth. Students may not know how carbon moves through the four spheres or how humans play a role in the carbon cycle. Students may not know much about the grassland ecosystem and may think it is not essential.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Background Video</u>- Briefly introduce or review the cycling of matter and energy in the carbon cycle. Show this Khan Academy video reviewing the carbon cycle. https://www.khanacademy.org/science/high-school-biology/hs-ecology/hs-biogeochemical-cycles/v/carbon-cycle Review the four earth's sphere: atmosphere, biosphere, geosphere, hydrosphere.</p> <p><u>Background Research</u>- Students will conduct an internet search to learn more about the carbon cycle, look at different diagrams or models, and research carbon cycling in a grassland ecosystem.</p>		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> • Computers with internet access • Paper • Pencil • Colored Pencils/Markers <hr/> <p><u>Carbon Cycle Diagramming</u>- Students will use the information learned from their background research to create a diagram demonstrating the cycling of carbon in a grassland ecosystem. Students will show how carbon moves through the atmosphere, biosphere, geosphere, and hydrosphere. The diagram must include components from each of the following:</p> <ul style="list-style-type: none"> • Atmosphere • Biosphere • Geosphere • Hydrosphere 		

- Anthroposphere (Humans)

The diagram should include a key and some sort of system to show the movement of carbon and explanations, as needed.

Class Discussion- Students will participate in a class discussion.

Lead a class discussion using the following questions:

- How is the carbon cycle represented in the grasslands?
- Why is the carbon cycle important to life in the grasslands?
- What is the role of the sun in the carbon cycle?
- What is the role of humans in the carbon cycle?
- How does plant photosynthesis contribute to the carbon cycle?

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Review the carbon cycle.

Review lesson vocabulary.

Vocabulary:

Carbon Cycle- A biogeochemical cycle in which carbon is exchanged among the biosphere, hydrosphere, atmosphere, and geosphere

Grassland- An area that is dominated by grass or grass-like vegetation

Biosphere- The parts of the earth in which organisms are able to live

Atmosphere- Envelope of gases surrounding the Earth

Geosphere- Outer parts of the Earth's surface, including the crust and upper mantle

Hydrosphere- All the water on Earth, including lakes, streams, and oceans

Carbon Sink- A natural reservoir that holds more carbon than it releases

ELABORATE: Applications and Extensions:

- **Atmosphere, Weather and Climate, Lesson One:** Weather and Climate
- **Atmosphere, Weather and Climate, Lesson Two:** Paleoclimate

EVALUATE:

Summative Assessment (Quiz / Project / Report): Carbon Cycle Diagram, Class Discussion

At the end of the lesson, students will be able to:

1. Demonstrate the exchange of energy and matter in a grassland ecosystem
2. Explain the role of the carbon cycle to life on earth

Elaborate Further / Reflect: Enrichment:

Grasslands NatGeo: <https://www.nationalgeographic.com/environment/habitats/grasslands/>

Grassland Carbon Management: <https://www.fs.usda.gov/ccrc/topics/grassland-carbon-management>

Carbon Cycle and Ecosystems: <https://terra.nasa.gov/science/carbon-cycle-and-ecosystems>

The Carbon Cycle NASA: <https://earthobservatory.nasa.gov/features/CarbonCycle>

Weather and Climate

This section contains two lessons exploring weather and climate in a grassland ecosystem. Students will use local weather and climate data to identify and analyze climate trends and explore proxy data as a method of reconstructing paleoclimate data. Lessons are geared towards grades 9-12.

The difference between climate and weather is a measure of time. Weather is the condition of the atmosphere over a short period of time, climate is how the atmosphere acts over a long period of time.¹ Weather events impacts our daily lives, but climate also has a major impact in our lives and communities. Many industries are directly dependent on weather and climate. If an area experiences extreme drought or severe weather, the industry could be negatively impacted. Additionally, populations living in areas prone to natural disasters are at risk due to severe weather events such as hurricanes or tornados. Climate change impacts communities in the United States and around the world in a variety of ways. Many areas in the Great Plains are experiencing more frost-free days, resulting in a longer growing season accompanied with hotter, drier summers.² Island communities are at risk of losing food sources and valuable land as the oceans continue to warm and rise.² We can use proxy data to reconstruct the climate from thousands of years ago. By exploring past climate data, we can learn about climate trends and prepare for the future.

References:

1. Climate vs. Weather. All About Arctic Climatology and Meteorology. National Snow & Ice Data Center. Retrieved from: https://nsidc.org/cryosphere/arctic-meteorology/climate_vs_weather.html
2. Extreme Weather. National Climate Assessment. Retrieved from: <https://nca2014.globalchange.gov/highlights/report-findings/extreme-weather>

Lessons:

1. Weather and Climate
 - Weather and climate mini game—students will determine whether a statement represents weather or climate
 - Weather and climate video—students will watch a short video explaining the difference between weather and climate
 - Data collection—students will collect current climate data and answer a series of questions
 - Climate at a glance—students will use the NOAA climate at a glance website to explore historical climate data for the state of Nebraska
2. Paleoclimate
 - Introduction video—students will watch a video introduction paleoclimate reconstruction
 - Tree Ring Activity—students will learn how to age a tree by counting its rings
 - Grasslands Paleoclimate Reconstruction—students will research and report on the paleoclimate of a national grassland of their choice

Lesson One: Weather and Climate

Written by Michael Burke, Adapted by Emily Reif

Grade/ Grade Band: 9-12	Topic: Earth Science/ Weather and Climate	Lesson # 1 in a series of 2 lessons
<p>Brief Lesson Description: In this lesson, students will explore weather and climate data in your local area and identify climate and weather trends.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Understand the system interactions that control climate and weather 2. Explain the difference between weather and climate 		
<p>NGSS Standards: SC.HS.12 Weather and Climate SC.HS.12.2 Gather, analyze, and communicate evidence to support that Earth's climate and weather are influenced by energy flow through Earth systems.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Collecting, analyzing, and interpreting data; basic weather vocabulary</p> <p>The difference between <u>climate</u> and <u>weather</u> is a measure of time. Weather is the condition of the atmosphere over a short period of time, climate is how the atmosphere acts over a long period of time. Weather events impacts our daily lives, but climate also has a major impact in our lives and communities.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> ● Evaluate Evidence ● Apply Scientific Reasoning ● Ask Questions & Define Problems ● Analyze & Interpret Data 	<p>Disciplinary Core Ideas: SC.HS.12.2.B Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> ● Patterns ● Cause & effect ● Stability & change
<p>Possible Preconceptions/Misconceptions: Weather and climate are terms that are often incorrectly interchanged. This lesson and activities explore weather and climate using authentic, student-generated data sources and a national database.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Climate or Weather Mini Game</u>: Students are separated into groups of 4, two teams of two. Groups will read off statements and the other team guesses if the statement is about weather or climate. Most correct wins the mini game.</p> <p>Sample statements:</p> <ol style="list-style-type: none"> 1. “Rising oceans cover up a coastal wetland, eliminating nesting sites for the clapper rail” (climate) 2. “A warm winter helps more juvenile alligators survive.” (weather) <p><u>Weather vs Climate Video</u>: Students will watch this video explaining the difference between weather and climate https://www.youtube.com/watch?v=YbAWny7FV3w</p>		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> ● Computers with internet access ● Paper ● Pencil ● Student worksheets <p>Print out enough worksheets for each student</p> <hr/> <p><u>Data Collection Activity</u>: Separate students into groups of two or three. Once grouped, they will use the National Weather Service page to find current observations of their local area (https://www.wrh.noaa.gov/map) *Surface Observations layer must be turned on. Students should collect data on the following variables:</p> <ul style="list-style-type: none"> ● Temperature ● Relative humidity ● Wind speed and direction ● Cloud type 		

- Cloud cover

After data is collected, ask the following questions:

- Do these measurements indicate weather or climate at your location? What is the difference between weather and climate?
- Approximately how long of a span of years do climatologists need to study trends in weather patterns to determine a region's climate or changes in climate?
- Why can't we just use the weather results from one day?

Climate at a Glance Activity: Students will use the NOAA Climate at a Glance website to find historical climate data on the state of Nebraska (<https://www.ncdc.noaa.gov/cag/statewide/mapping>). Using the website, students will find average temperature, maximum and minimum temperature, precipitation and drought parameters for the current year and every 15 years back. Students will calculate the average of each. Students can report data for each parameter in the chart found in lesson materials.

After data is collected students should complete the worksheet located in lesson materials. (a student worksheet is located in lesson materials):

- Why do you think you were asked to record the variable measurements in increments of 30 years? (Climate patterns are averaged over many years.)
- Are there trends in any of the variables over 120 years? If so, what do you think might contribute to these trends? (Students may note that temperature decreases, then increases. Industrialization has led to the burning of fossil fuels for travel, manufacturing, heating, and cooling. Increases in population are adding to these upward trends.)
- What is weather?
- What is climate?
- How are these two terms alike, and how are they different? (Weather and climate are based on similar parameters [temperature, rainfall, humidity, wind speed]. Weather is what is happening short-term; climate is weather patterns over long periods of time [generally 30 years or more].)
- How do the data you collected compare to the data (from the same geographic location) from this year?
- How do they compare to 15 years ago?
- One hundred and twenty years ago? (Students may note that temperatures, precipitation, and drought severity are different for other years and whether there are trends toward warmer or colder average temperature.)
- Why is it important to learn about your local weather?

EXPLAIN: Concepts Explained and Vocabulary Defined:

Explain how weather forecasts use observations, data, and technology to predict the weather.
Describe what information can be learned from the information shown on weather maps.
Identify the factors that influence temperature and precipitation.
Review lesson vocabulary.

Vocabulary:

Weather- condition of the atmosphere over a short period of time
Climate- long-term pattern of weather in a particular area
Precipitation- water released from clouds in both frozen and liquid forms
Humidity- concentration of water vapor in the atmosphere
Temperature- degree of hotness or coldness measured by the thermometer with a numerical scale
Dew Point- atmospheric temperature at which water vapor condense to form liquid droplets
Drought- prolonged period of below average precipitation
Cold Front- transition zone in which a cold air mass replaces a warm air mass
Warm Front- transition zone in which a warm air mass replaces a cold air mass

ELABORATE: Applications and Extensions:

- **Grassland Atmosphere, Lesson Two:** Paleoclimate

EVALUATE:

Formative Monitoring (Questioning / Discussion): Student worksheets

At the end of the lesson, students will be able to:

1. Identify and explain the difference between weather and climate
2. Analyze climate and weather data from their local area

Additional Resources:

NASA Weather vs. Climate video: <https://www.youtube.com/watch?v=vH298zSCQzY>
NatGeo Weather vs. Climate video: https://www.youtube.com/watch?v=cBdxDFpDp_k
NOAA Weather vs. Climate: <https://www.ncei.noaa.gov/news/weather-vs-climate>
Cold Fronts: [http://ww2010.atmos.uiuc.edu/\(Gh\)/guides/mtr/af/frnts/cfrnt/def.rxml](http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/af/frnts/cfrnt/def.rxml)

Lesson Materials:

Climate at a Glance Activity Chart

	Average Temperature (C/F)	Max Temperature (C/F)	Min Temperature (C/F)	Precipitation Amount (in.)	Palmer Drought Severity Index (PDSI) (-10 [dry] to +10 [wet])
Current Year					
15 years ago					
30 years ago					
60 years ago					
90 years ago					
120 years ago					
Average					

Climate at a Glance Activity Student Worksheet

1. Why do you think you were asked to record the variable measurements in increments of 30 years?
2. Are there trends in any of the variables over 120 years? If so, what do you think might contribute to these trends?
3. What is weather?
4. What is climate?
5. How are these two terms alike, and how are they different?
6. How do the data you collected compare to the data (from the same geographic location) from this year?
7. How do they compare to 15 years ago?
8. One hundred and twenty years ago?
9. Why is it important to learn about your local weather?

Lesson Two: Paleoclimate

Written by Michael Burke, Adapted by Emily Reif

Grade/ Grade Band: 9-12	Topic: Earth Science/ Weather and Climate	Lesson # <u>2</u> in a series of <u>2</u> lessons
<p>Brief Lesson Description: In this lesson, students will reconstruct paleoclimates and present information on the impact of human driven climate change.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Discuss the evidence of factors influencing changes in global temperature over time 2. Identify examples of paleoclimate proxy data 		
<p>NGSS Standards: SC.HS.12.2 Gather, analyze, and communicate evidence to support that Earth's climate and weather are influenced by energy flow through Earth systems.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Differences between weather and climate and that climate is changing. Basic definitions of climate, weather and global warming. Background knowledge from lesson one</p> <p>The difference between <u>climate</u> and <u>weather</u> is a measure of time. Weather is the condition of the atmosphere over a short period of time, climate is how the atmosphere acts over a long period of time. Weather events impacts our daily lives, but climate also has a major impact in our lives and communities. We can use proxy data to reconstruct the climate from thousands of years ago. By exploring past climate data, we can learn about climate trends and prepare for the future.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> ● Evaluate Evidence ● Apply Scientific Reasoning ● Ask Questions & Define Problems ● Analyze & Interpret Data 	<p>Disciplinary Core Ideas: SC.HS.12.2.B Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> ● Patterns ● Cause & effect ● Stability & change
<p>Possible Preconceptions/Misconceptions: Climate change isn't real. A single person can't impact the Earth's climate. Students may not know much about how Earth's climate has changed throughout its history.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Introduction Video:</u> Students will watch a video on climate history reconstruction. Reconstructing Climate History – How Do We Know: https://www.youtube.com/watch?v=PfjkeE-ABGI</p> <p><u>Background Lecture:</u> Present a brief background lecture on paleoclimatology which includes information on studying previous climates, the scientific methods used, and an introduction to different types of climate proxy data including the Milankovitch Theory, tree rings, coral reefs, ice cores and sediment varves.</p>		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> ● Computers with internet access ● Paper ● Pencil ● Student worksheets <p>Print out enough worksheets for each student Prepare a background lecture on paleoclimate proxy data</p> <hr/> <p><u>Tree Ring Activity:</u> Show brief videos on how to age a tree using tree rings. Wyoming Extension: https://www.youtube.com/watch?v=XSTn2SMRYTg BYU Tree Stories: https://www.youtube.com/watch?v=xmZO7aRgcW4 After watching background videos, students will complete the tree ring activity page. Students should provide an explanation of the tree age and discuss possible reasons for changes in tree ring spacing.</p>		

**An activity extension: reach out to your local extension, forest service, or state land management agency to obtain actual tree cross sections for aging.

Great Plains Paleoclimate Research: Students will conduct research on the paleoclimate of the Great Plains. Students will research and choose one national grassland, located in the Great Plains, as the focus of their investigation. Students should try to find research and studies conducted on the paleoclimate of the Great Plains. Students need to take detailed notes and write a report on types of proxy data used in the aging process.

The report should include the following topics:

- Types of proxy data found in the Great Plains
- Explanation of the study
- Examples of paleoclimate reconstruction
- What can be learned from study paleoclimatology

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer student questions.

Explain what can be learned from studying paleoclimatology.

Explain how proxy data is used.

Review lesson vocabulary.

Vocabulary:

Climate- long-term pattern of weather in a particular area

Climate change- long-term shift in climate patterns

Greenhouse gas- gases in Earth's atmosphere that trap heat

Paleoclimatology- the study of past climates, prior to the widespread availability of written records

Proxy Data- in paleoclimatology, the natural recorders of climate variability (ice cores, tree rings, pollen, sediment, coral reefs)

ELABORATE: Applications and Extensions:

- Exploring Earth's Atmosphere

EVALUATE:

Summative Assessment (Quiz / Project / Report): Great Plains Paleoclimate Report

At the end of the lesson, students will be able to:

1. Discuss different types of paleoclimate proxy data
2. Identify the importance of studying past climate patterns

Additional Resources:

NOAA Paleoclimatology Education: <https://www.ncdc.noaa.gov/data-access/paleoclimatology-data/education-outreach>

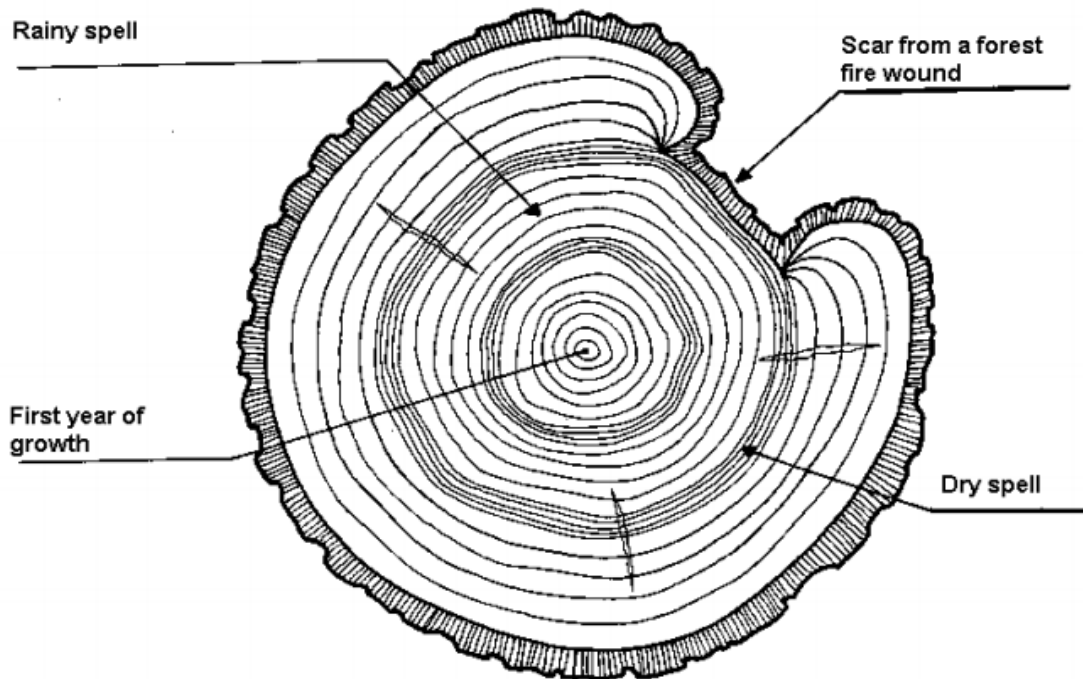
NOAA Paleoclimatology Datasets: <https://www.ncdc.noaa.gov/data-access/paleoclimatology-data/datasets>

Climate Proxies: <https://serc.carleton.edu/microbelife/topics/proxies/paleoclimate.html>

Climate Data: <https://hprcc.unl.edu>

Lesson Materials:

Tree Ring Activity



1. How old is this tree? _____
2. Locate the pointer marked **First year of growth**.
 - a. What year did this tree start to grow? (HINT: To calculate the tree's first year of growth: $2011 - \text{age of the tree} = \text{tree's first year of growth}$) _____
3. Locate the pointer marked **Scar from a forest fire wound**.
 - a. How many years ago did a forest fire wound the tree? (HINT: Count the number of rings between the damage mark and the outer ring.) _____
4. Locate the pointer marked **Dry spell**.
 - a. Note the annual layers are very narrow in this part of the tree record.
 - b. How many years ago did the drought start? (HINT: Count back from the outer ring to the earliest narrow ring that is closest to the *First year of growth*.) _____
 - c. How many years were in this dry spell? (HINT: Count the number of narrow rings in this area of the tree record.) _____
5. Locate the pointer marked **Rainy spell**. Note that the rings are wider in this area of the tree record.
 - a. How many years were in this rainy spell? (HINT: Count the number of wider rings in this area of the tree record.) _____

A herd of bison is grazing in a lush green field. In the foreground, a bison is lying down, facing left. Behind it, several other bison are standing and grazing. The background features a line of trees with dense green foliage. The word "Biosphere" is overlaid in large, bold, black letters across the center of the image.

Biosphere

Biosphere

This packet contains three sections with seven lessons to investigate the diverse flora and fauna of the grasslands of the United States.

The Biosphere is the part of Earth occupied by living organisms and may include parts the surface of the Earth as well as the Atmosphere, Hydrosphere, and Geosphere. America's grasslands are a highly diverse ecosystem with a lot of plant and animal life. However, like many ecosystems, that grasslands have been converted into other uses. Currently, only about one percent of the original eastern tallgrass prairie ecosystem remains intact. The primary cause of conversion is agriculture. In the late 1800s, grasslands were deemed highly fertile due to the abundance of below ground biomass. Today, approximately 325 million acres of the Great Plains are in agricultural use. In addition to the loss of prairie land, this region is also threatened by exotic and invasive plant species, which were often introduced for conservation purposes. Understanding how humans, plants, and animals interact in the grasslands is important for resource management and agricultural production.

Sections:

1. Floral and Faunal Resources
2. Eastern Redcedar Invasion
 - Eastern Redcedar Exploration
 - Townhall Meeting
 - Reflection and Wrap Up
3. Grassland Biodiversity
 - Grassland Animals
 - Grassland Plants
 - Grassland Food Web

Floral and Faunal Resources

This section contains one lesson to explore the diversity of plant and animal species in a grassland ecosystem. Students will research and report on one plant or animal species endemic to the Great Plains. Lessons are geared towards grades 9-12.

The Great Plains is a geographical location situated between the Rocky Mountains to west and the Mississippi River to the east. The Great Plains stretch from southern Canada to Texas. This region is primarily composed of spreading grassland, also called prairie. From a distance, the grasslands may not seem like much, but it is a highly diverse ecosystem. According to the Great Plains Nature Center, Kansas is home to 87 mammal species, 457 bird species, over 100 reptile and amphibians, and over 15,000 insects.¹ In addition to all those diverse animal species, there are over 1,100 plant species in Kansas.¹ These highly diverse grasslands are vulnerable to habitat loss due to agricultural development and urbanization. The Great Plains have greatly changed from the historical ecosystem due to agricultural development. Currently, only one percent of the original eastern tallgrass prairie ecosystem remains intact, while approximately 325 million acres of the Great Plains are in agricultural production.²

References:

1. Flora & Fauna. (n.d.). Great Plains Nature Center. Retrieved from <https://gpnc.org/flora-fauna/>
2. Case, R.M. and D.J. Wishart. (n.d.) Wildlife and Agriculture. Encyclopedia of the Great Plains. Retrieved from <http://plainshumanities.unl.edu/encyclopedia/doc/egp.ag.076>

Activities:

- Class Discussion to gauge prior knowledge of great plains ecosystems and biodiversity
- Great Plains Animals/Plants background videos to show biodiversity and engage student interests
- Background Research, students will research plant and animal species of their interest to learn more about Great Plains ecosystems and biodiversity
- Great Plains Species Report, students will present their research on one species

Floral and Faunal Resources

Grade/ Grade Band: 9-12	Topic: Natural Resources/Ecology	Lesson # 1 in a series of 1 lesson
<p>Brief Lesson Description: The Great Plains are home to many unique plants and animals. In this lesson, students will research and report on one plant or animal species endemic to the Great Plains.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. identify how prehistoric and historic inhabitants of the Great Plains used floral and faunal resources 2. Research and write a report on one species native to the Great Plains 		
<p>NGSS Standards: SC.HS.7 Interdependent Relationships in Ecosystems SC.HS.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic ecology and natural resource background</p> <p>The <u>Great Plains</u> are home to thousands of unique <u>flora</u> and <u>fauna</u> species. This region is made up of large swaths of <u>grasslands</u>, which are composed primarily of grass species. While highly diverse, the grasslands are also very vulnerable to fragmentation and habitat loss.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Asking Questions and Defining Problems • Obtaining, Evaluating, and Communicating Information • Planning and Carrying Out Investigations 	<p>Disciplinary Core Ideas: SC.HS.7.2.D Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Patterns • Cause & Effect • Stability & Change
<p>Possible Preconceptions/Misconceptions: Students may not know how diverse plant and animal life is on the Great Plains.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Class Discussion:</u> Lead a class discussion to provoke questions about grasslands in the United States. Use the following questions to guide discussion:</p> <ul style="list-style-type: none"> • What is a grassland? • Where is the Great Plains? • What types of animals live in the grasslands? • How would you describe the ecosystem of the Great Plains? <p><u>The Great Plains- America's Lingering Wild Video:</u> Students will watch a short video showcasing animal of the Great Plains. https://www.youtube.com/watch?v=oEH7nZpNSL8</p> <p><u>Exploring the Depths of Prairie Plants Video:</u> Students will watch a short video showcasing plants of the Great Plains. https://www.youtube.com/watch?v=bzQ7x3b13Z4</p>		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> • Paper • Pencil • Computers with internet access <hr/> <p><u>Background Research:</u> Students will research plants and animals native to the Great Plains. Students should choose one species that they are interested in learning more about. The species can be a plant or animal, alive or extinct. Students need to take detailed notes and include references from their background research.</p> <p><u>Great Plains Species Report:</u> Students will create a report on the species of their choice. The report should include the following:</p> <ul style="list-style-type: none"> • Images of the species • Species characteristics • Species role in the ecosystem 		

- Population distribution- historical range, current range
- Habitat
- Food source (for animals)
- Use by populations living in the Great Plains
- References

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Review main components of an ecosystem.

Review lesson vocabulary.

Vocabulary:

Grassland- an area that is dominated by grass or grass-like vegetation

Ecosystem- a community of interacting organisms and their physical environment

Great Plains- a prairie landscape region between the Rocky Mountains and the Mississippi River

Flora- relating to the natural vegetation including plants, fungi, and algae in a geographical region

Fauna-relating to the animals in a geographical region

Biodiversity- variety and variability of living organisms in an ecosystem

ELABORATE: Applications and Extensions:

- **Biosphere, Eastern Redcedar Invasion**
- **Biosphere, Grassland Biodiversity**

EVALUATE:

Summative Assessment (Quiz / Project / Report): Great Plains Species Report

At the end of the lesson, students will be able to:

1. Explain the role a species plays in an ecosystem
2. Identify how humans in the Great Plains interacted with and used floral and faunal resources

Additional Resources:

Wildlife and Agriculture: <http://plainshumanities.unl.edu/encyclopedia/doc/egp.ag.076.xml>

Animals of the Great Plains: <https://www.worldwildlife.org/stories/animals-of-the-northern-great-plains>

Description of the Great Plains: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1255057.pdf

Plant Use in the Great Plains: <http://plainshumanities.unl.edu/encyclopedia/doc/egp.fol.034.xml>

Great Plains Plants: <https://www.gpnps.org>

Great Plains Nature Center: <https://gpnc.org/flora-fauna/>

Eastern Redcedar Invasion into Grassland Systems

Written by Tracy Ensor, adapted by Emily Reif

This section contains three lessons that explore the ecological impacts of woody encroachment into grasslands throughout the Great Plains. Lessons are geared towards grades 9-12.

The spread of eastern redcedar (*Juniperus virginiana*) throughout the Great Plains has disrupted native prairie communities. This primarily affects the biosphere, but impacts to soils, livestock, and water have been documented.¹ Eastern redcedar are endemic to the eastern Great Plains but have spread aggressively into the western region due to the species fast growth rate, adaptability to climate and topographic conditions, and high reproductive output. Historically, eastern redcedar trees were planted in windbreaks and used as erosion control to stabilize soil. Humans have contributed to the spread of the species through such actions, and by passively managing grasslands through grazing-only methods. Additionally, the removal of natural fire from the prairie landscape is a contributing factor in the spread of woody vegetation. As climate change continues, eastern redcedar has the potential to move into previously unaffected areas due to its adaptability and lack of management. The spread of eastern redcedar is threatening the overall resilience of grasslands throughout the Great Plains. Disruptions to animal populations, plant composition and production, livestock production, wildfire risk, and soil composition are just some of the documented disturbances caused by eastern redcedar encroachment¹.

References:

1. Bielski, C.H., Twidwell, D., & Allen, C.R. The Eastern Redcedar Science Literacy Project. Retrieved from cedarliteracy.unl.edu (Last updated 17 September 2018).

Lessons:

1. Eastern Redcedar Exploration:
 - Research activity—online reading and research
 - Messy Picture activity—students will complete a worksheet on information they know and information they want to know.
2. Town Hall Meeting:
 - Mock Stakeholder Engagement activity—students will act out a dilemma and reflect on the activity
 - City Council Vote activity—students will share their argument to a panel that will then vote on the issue
3. Reflection and Wrap Up:
 - Class Discussion—students will participate in a class discussion and reflect on lessons one and two
 - 10-Minute Essay activity— students will complete a 10-minute essay activity to wrap up the lesson

Lesson One: Eastern Redcedar Exploration

Grade/ Grade Band: 9-12	Topic: Ecology/ Natural Resources	Lesson # 1 in a series of 3 lessons
Brief Lesson Description: In this lesson, students will research eastern redcedar (ERC) invasion and identify the problem of woody species encroachment.		
Performance Expectation(s): Students will be able to: <ol style="list-style-type: none"> 1. Identify the ecological impact of woody species encroachment in grassland ecosystems. 2. Analyze and communicate the interdependent relationships in grassland ecosystems. 		
NGSS Standards: SC.HS.7 Interdependent Relationships in Ecosystems SC.HS.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems. SC.HS.15 Sustainability SC.HS.15.5 Gather, analyze, and communicate evidence to describe the interactions between society, environment, and economy.		
Narrative / Background Information		
Prior Student Knowledge: Basic ecology background and terminology; Note-taking skills Students will review eastern redcedar background information during opening activity		
Science & Engineering Practices: <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	Disciplinary Core Ideas: SC.HS.7.2.E Design, evaluate, and refine a solution for increasing the positive impacts of human activities on the environment and biodiversity. SC.HS.15.5.E Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	Crosscutting Concepts: <ul style="list-style-type: none"> • Patterns • Cause & effect • Environmental Science • Communication
Possible Preconceptions/Misconceptions: Students may believe that all trees are beneficial and think since the eastern redcedar is native to some areas of the Great Plains is not invasive. Students may not know the difference between native and naturalized species or aggressive and invasive species. Students may think that native and naturalized species are the same and that aggressive and invasive species are the same.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Background Reading:</u> Individually, or in groups of two or three, students will read eastern redcedar invasion information online, then search the internet for two additional articles about eastern redcedar encroachment. By end of class, students should be able to state the problem that eastern redcedar are overtaking grasslands throughout the Great Plains region. Good note taking is crucial to the success of this lesson moving forward, so a rubric is provided to serve as a student notetaking guide. Students will visit https://agronomy.unl.edu/eastern-redcedar-science-literacy-project to learn background information about eastern redcedar in the Great Plains. Students will review the topics of Impacts, Invasions, and FAQs, and read why scientists are concerned about the spread of eastern redcedar. After reading the provided material, students will find at least two other sources that describe eastern redcedar and are relevant to the discussion. Students should formally cite the article by including authors, title, and URL. Students should include any relevant information in their notes. Finally, students will describe what needs to be done to address the issue of ERC invasion into grassland systems by creating a problem statement.		
EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i> <ul style="list-style-type: none"> • Paper • Pencil 		

- Computers with internet access
- Student worksheets

Print out enough student worksheets for each student

Messy Picture: Students will create a “messy picture” that includes five items of what they know, and three items of what they need to know. Then students will add more information to their pictures based on a discussion of a modified CATWOE checklist from Soft System Methodology (Mulder, 2018). Students will share their picture with the class. A worksheet to outline the process is provided.

Mulder, P. (2018). Soft Systems Methodology (SSM). Retrieved [April 2019] from ToolsHero: <https://www.toolshero.com/problem-solving/soft-systems-methodology-ssm/>

EXPLAIN: Concepts Explained and Vocabulary Defined:

Clarify any questions from students.
 Explain the CATWOE checklist and how to use it.
 Review lesson vocabulary.

Vocabulary:

Invasive Species- an organism that causes ecological harm in an environment where it is not native
Eastern redcedar- a woody plant species in the juniper family; native to the eastern Great Plains
Woody Plant Encroachment- increase in density, cover, or biomass of a woody shrub or plant

ELABORATE: Applications and Extensions:

- **Eastern Redcedar Invasion into Grassland Systems, Lesson Two:** Town Hall Meeting
- **Eastern Redcedar Invasion into Grassland Systems, Lesson Three:** Reflection and Wrap Up
- **Anthroposphere, Fire Frenzy**
- **Anthroposphere, Human Dimension of the Grasslands**

EVALUATE:

Summative Assessment (Project): Messy Picture

At the end of the lesson, students will be able to:

1. Communicate how different components of the grassland ecosystem are interconnected
2. Identify what has led to the spread of woody species into native grasslands

Additional Resources:

Eastern redcedar Wiki: https://en.wikipedia.org/wiki/Juniperus_virginiana
 Eastern redcedar NRCS: <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ks/newsroom/features/?cid=nrcseprd468806>
 Woody Weeds: <https://extension.sdstate.edu/woody-weeds-eastern-red-cedar>

Lesson Materials:

Background Reading Rubric

Eastern redcedar (ERC) spread throughout the Great Plains grasslands

Why was ERC rare historically?	How has ERC become invasive and what human practices have helped the spread?	What are some of the impacts of ERC invasion?	What are some potential losses by continued spread of ERC?	What other information do you want to include?

What is your problem statement?

Messy Picture

Read over your notes and analyze them for patterns. As you are thinking, discuss the following with your group:

1. What do you know about Eastern Red Cedar invasion into Great Plains grasslands? Write five facts that you know.
2. What other information do you need to know about ERC invasion? Write three questions that remain.

Now it's time to create a "messy picture" diagram to relate the situation you've just described. Think about how best to organize your answers into picture form. Draw them out. How do these ideas connect to one another? Draw arrows and connections between your pictures to show how they are linked.

Add some more detail to your picture. Think through the following categories and brainstorm who or what needs to be added to each category. Then look at your messy picture again. How can you incorporate these new ideas into your picture? Does it affect the organization of your picture? Reorganize as needed so your picture makes sense.

- **People:**
 - Who is affected by the problem?
 - Who will carry out any potential solutions to the problem?
 - Who is content with the situation as-is, or doesn't want a solution to happen?
- **Worldview:**
 - Why is our current system in place?
 - What advantages does it provide?
- **Environmental constraints:**
 - What limits are placed on the solving the problem?
- **Potential solution(s):**
 - Is there more than one solution?

Present your messy picture to the class.

Have the questions you needed more information about in Question 2 been answered by other groups? If not, write down your questions and do more background research to find the answers.

Lesson Two: Town Hall Meeting

Grade/ Grade Band: 9-12	Topic: Ecology/ Natural Resources	Lesson # 2 in a series of 3 lessons
<p>Brief Lesson Description: In this lesson, students will participate in a mock town hall meeting to discuss the ecological impacts of eastern redcedar invasion in the Great Plains.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Identify the ecological impact of woody species encroachment in grassland ecosystems. 2. Analyze and communicate the interdependent relationships in grassland ecosystems. 		
<p>NGSS Standards: SC.HS.7 Interdependent Relationships in Ecosystems SC.HS.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems. SC.HS.15 Sustainability SC.HS.15.5 Gather, analyze, and communicate evidence to describe the interactions between society, environment, and economy.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic ecology terminology; Communication skills; Eastern redcedar invasion from lesson one</p> <p>Landowners, public land managers, and the general public often collaborate to work on natural resource management issues. These <u>stakeholders</u> play an important role in the decision-making process. A <u>town hall meeting</u> gives the public an opportunity to ask questions and gives land managers an opportunity to explain resource management plans.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	<p>Disciplinary Core Ideas:</p> <p>SC.HS.7.2.E Design, evaluate, and refine a solution for increasing the positive impacts of human activities on the environment and biodiversity.</p> <p>SC.HS.15.5.E Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Patterns • Cause & effect • Environmental Science • Communication
<p>Possible Preconceptions/Misconceptions: Students may still be uncertain about the difference between native and invasive species. Student can refer back to their background reading materials for a refresher. Students may not know how to participate in a town hall style meeting or how such a meeting operates.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Lesson One Review:</u> Briefly review and answer any questions from lesson one. Students should recap on what they learned. Lead a class discussion with the following questions:</p> <ul style="list-style-type: none"> • What caused the spread of eastern redcedar into grasslands? • Who or what is impacted by woody species encroachment? • How did humans play a role in the spread of eastern redcedar? 		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> • Paper • Pencil • Student worksheets <p>Print enough worksheets for each student</p>		
Part One		

Town Hall Meeting: Students will participate in a mock town hall meeting, in which a city council panel will hear concerns and vote to ban on the planting of shelterbelts containing Eastern redcedar at their next meeting.

Break students into groups and assign students a specific role that represents one side of the issue. Roles from scientific, economic, and environmental fields are chosen to represent both pro-ban and anti-ban sides of the debate. These categories also help students plan and develop their specific roles by providing a starting point in developing their perspective.

Once students are assigned a role, each group will use the notes they previously compiled to compose an argument to be presented in front of the city council. A worksheet to compile arguments from both sides of the issue is provided.

Groups will fill out the worksheet, then prepare a 3-minute statement on their respective stance that will be presented to the city council panel. Points will be given for discussion of ERC invasiveness, human effects on the system, historical background, and strength of your position.

Part Two

City Council Vote: Students will present their argument to the city council for a vote. The order of presenters at the town hall meeting will be listed on the board.

Each group will receive three minutes to address their arguments toward the city council panel.

The panel is comprised of the teacher, as well as two other adults such as the principal, local Extension personnel, a local elected official, or other adult. Following each group's presentation, there will be two minutes for questions to be asked of the group about their stance: first by the panel, then by the class. Once all groups have presented, the panel will ask any final questions and discuss. They will then state their decision on the topic based on the group presentations. The panel will also share the reasoning behind their decision.

Part Three

Student Reflection: Students will individually write about their experience in this exercise.

Papers should include answers to the following:

1. What were your initial thoughts on the topic?
2. Did you have any previous knowledge to draw upon at the beginning?
3. Two facts about the spread of Eastern Red Cedar in grassland ecosystems. How did these facts help shape the rest of this week?
4. Describe the messy picture exercise. Did this help you prepare?
5. reflection about your assigned role. Did you agree with the stance you had to take? Did this make it harder or easier for you to prepare for the town hall meeting? Why?
6. Now that you have heard multiple sides of this issue, did you agree with the panel's decision? Why or why not?

EXPLAIN: Concepts Explained and Vocabulary Defined:

Clarify any questions from students.

Explain the process of a town hall meeting.

Review lesson vocabulary.

Vocabulary:

Invasive Species- an organism that causes ecological harm in an environment where it is not native

Eastern redcedar- a woody plant species in the juniper family; native to the eastern Great Plains

Town Hall Meeting- an event in which public officials answer questions from the public

Stakeholder- a person with an interest or concern in some matter

ELABORATE: Applications and Extensions:

- Eastern Redcedar Invasion into Grassland Systems, Lesson Three: Reflection and Wrap Up
- Anthroposphere, Fire Frenzy

EVALUATE:

Summative Assessment (Project / Report): Townhall Meeting Reflection

At the end of the lesson, student will be able to:

1. Communicate how different components of the grassland ecosystem are interconnected
2. Identify what has led to the spread of woody species into native grasslands
3. Provide a recommendation to combat the spread of woody species in the Great Plains

Elaborate Further / Reflect: Enrichment:

Town Hall Meeting Wiki: https://en.wikipedia.org/wiki/Town_hall_meeting

Eastern redcedar Wiki: https://en.wikipedia.org/wiki/Juniperus_virginiana

Eastern redcedar NRCS: <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ks/newsroom/features/?cid=nrcseprd468806>

Woody Weeds: <https://extension.sdstate.edu/woody-weeds-eastern-red-cedar>

Lesson Materials:

Town Hall Meeting Worksheet

Use these questions to help your group develop your argument either for or against the ban based on the role assigned to you. Use your notes and your messy picture to help you answer the questions. Then compose a 3-minute statement summarizing your stance that will be presented to the city council panel. Points will be given for discussion of ERC invasiveness, human effects on the system, historical background, and strength of your position.

Roles at the Town Hall Meeting:

- **Prairie ecologist, pro ban (Scientific Interest):** the ecologist has conducted several studies on the spread of ERC. They come to the meeting to share facts taken from their research and published papers, including the role of fire in shaping the ecosystem.
- **Arbor Hill Tree Farm, pro ban (Economic Interest):** the tree farm is pro-ban because they provide alternative trees for windbreaks, and the sale of these other types of trees would provide more profit for their business.
- **Washburn Hunting Guides, anti-ban (Economic Interest):** the hunting guides find that deer tend to congregate in ERC windbreaks because the windbreaks offer protection and browsing opportunities. They have several windbreaks on their hunting acres, and this ban would negatively impact their business.
- **Homeowner, anti-ban (Economic Interest):** the homeowner has an ERC windbreak, and replacing that windbreak with another tree species would be cost-prohibitive and take many years to be as effective as the tall ERC windbreak currently on their property.
- **National Resources Conservation Service (NRCS), pro ban (Environmental Interest):** the NRCS is interested in grassland conservation, and the invasiveness of ERC in grassland ecosystems has had a profound effect on this ecosystem. They are prepared for the meeting with impacts made on the grassland system by ERC trees.
- **Arbor Day Foundation, anti-ban (Environmental Interest):** The mission of Arbor Day is to “inspire people to plant, nurture, and celebrate trees”. They provide ERC trees to plant in windbreaks and for wildlife food and protection.

Questions to help you frame your 3-minute statement:

1. Does your role support the ban? What reasons does your assigned role have for their position?
2. What is the alternative to their argument? Where are their blind spots?
3. How are humans affecting the system? What is your role doing to help or hurt the spread of ERC invasion?
4. What proof can you provide to support your position?
5. Include some historical background information of ERC spread to strengthen your position.
6. How does the invasive nature of ERC play into your position?
7. Compose your 3-minute argument for the council meeting tomorrow.

Lesson Three: Reflection and Wrap Up

Grade/ Grade Band: 9-12	Topic: Ecology/Natural Resources	Lesson # 3 in a series of 3 lessons
<p>Brief Lesson Description: In this lesson, students will review and reflection upon the activities from lessons one and two during a class discussion and short essay.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Identify the ecological impact of woody species encroachment in grassland ecosystems. 2. Analyze and communicate the interdependent relationships in grassland ecosystems. 		
<p>NGSS Standards: SC.HS.7 Interdependent Relationships in Ecosystems SC.HS.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems. SC.HS.15 Sustainability SC.HS.15.5 Gather, analyze, and communicate evidence to describe the interactions between society, environment, and economy.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic ecology terminology; Communication skills; Eastern redcedar invasion from lesson one and two</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	<p>Disciplinary Core Ideas: SC.HS.7.2.E Design, evaluate, and refine a solution for increasing the positive impacts of human activities on the environment and biodiversity. SC.HS.15.5.E Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Patterns • Cause & effect • Environmental Science • Communication
<p>Possible Preconceptions/Misconceptions: Students may have questions or need clarification on woody species encroachment in the grasslands.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Class Discussion:</u> Students will participate in a class discussion reflecting on their papers from lesson two. Lead a class discussion on the learning experience and eastern redcedar invasion in grassland ecosystems throughout the Great Plains. Lead a class discussion with the following questions:</p> <ul style="list-style-type: none"> • What are your thoughts on the townhall meeting? • Did you support the outcome of the meeting? Why or why not? • How have humans contributed to the spread of ERC? • What can be done to prevent the spread of ERC? • What is the ecological impact of woody species encroachment? 		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <u>10-Minute Essay activity:</u> Students will write a short paragraph on the following prompt: Imagine that you are asked to give a talk to community members about the spread of eastern redcedar in the Great Plains. Write a short introduction to your talk (no more than three sentences) describing the how human management practices have impacted the spread of ERC.</p>		
<p>EXPLAIN: Concepts Explained and Vocabulary Defined: Clarify any final student questions. Review lesson vocabulary.</p> <p>Vocabulary: <u>Invasive Species-</u> An organism that causes ecological harm in an environment where it is not native <u>Eastern redcedar-</u> A woody plant species in the juniper family; native to the eastern Great Plains</p>		

ELABORATE: Applications and Extensions:

- Anthroposphere, Fire Frenzy
- Anthroposphere, Human Dimensions of the Grasslands

EVALUATE:

Formative Monitoring (Questioning / Discussion): Class Discussion; Essay

At the end of the lesson, students will be able to:

1. Communicate how different components of the grassland ecosystem are interconnected
2. Identify what has led to the spread of woody species into native grasslands

Elaborate Further / Reflect: Enrichment:

Eastern redcedar Wiki: https://en.wikipedia.org/wiki/Juniperus_virginiana

Eastern redcedar NRCS: <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ks/newsroom/features/?cid=nrcseprd468806>

Woody Weeds: <https://extension.sdstate.edu/woody-weeds-eastern-red-cedar>

Grassland Biodiversity

Adapted from Platte River Prairies by Platte Basin Timelapse

This section contains three lessons exploring the biodiversity of Nebraska's grasslands by creating a digital animal collection, an herbarium, and a food web. Lessons are geared towards grades 9-12.

Grasslands are highly diverse ecosystems, with a lot of plant and animal life. There are approximately 1,500 plant species native to the state of Nebraska.¹ In addition to those native plant species, Nebraska is also home to more than 450 bird species, 61 reptile and amphibian species, 95 mammal species, and more than 28,000 insects.² While grasslands are very diverse, they are also threatened by land use change. Currently, only one percent of the original eastern tallgrass prairie ecosystem remains intact, while approximately 325 million acres of the Great Plains are in agricultural production.³

References:

1. Nebraska Game and Parks. (n.d.). Biodiversity—Plants. Retrieved from <http://outdoornebraska.gov/biodiversityplants/>
2. Rogers, L. (2016). Wildlife Study Guide—Review Materials. Nebraska Game and Parks. Retrieved from https://www.nrdnet.org/sites/default/files/wildlife_study_guide_2016.pdf
3. Case, R.M. and D.J. Wishart. (n.d.) Wildlife and Agriculture. Encyclopedia of the Great Plains. Retrieved from <http://plainshumanities.unl.edu/encyclopedia/doc/egp.ag.076>

Lessons:

1. Grassland Animals:
 - Animal exploration activity to provide background knowledge on animals in Nebraska
 - Grassland animal collection activity, students will choose ten animal species to research and create a digital collection
2. Grassland Plants:
 - Plant exploration activity to provide background knowledge on plants in Nebraska
 - Herbarium activity, students will create their own herbarium of grasslands plants (this activity has three format options)
3. Grassland Food Web:
 - Background lecture to review ecology basics
 - Online food web activity to demonstrate the flow of food through an ecosystem
 - Grassland food web model, students will create a food web for a grassland ecosystem

Lesson One: Grassland Animals

Grade/ Grade Band: 9-12	Topic: Earth Science/ Ecology	Lesson # 1 in a series of 3 lessons
Brief Lesson Description: In this lesson, students will explore the biodiversity of Nebraska’s grasslands by researching and identifying native animals.		
Performance Expectation(s): Students will be able to: <ol style="list-style-type: none"> 1. Identify native plants and animals commonly found in grasslands of Nebraska 2. Explain the factors that influence biodiversity 3. Construct and analyze a food web for a grassland ecosystem 		
NGSS Standards: SC.HS.7 Interdependent Relationships in Ecosystems SC.HS.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.		
Narrative / Background Information		
Prior Student Knowledge: Basic earth science background; knowledge of ecosystem interactions; knowledge of food webs From a distance, grasslands might just seem like a spreading grassy field, but that is not the case. Nebraska’s <u>grasslands</u> are a diverse <u>ecosystem</u> home to thousands of animal species. Each species plays a unique role in the ecosystem and depends on different habitats. However, grasslands are vulnerable to fragmentation and habitat loss. Understanding the unique ecosystem will allow for better management.		
Science & Engineering Practices: <ul style="list-style-type: none"> • Asking Questions and Defining Problems • Developing and Using Models 	Disciplinary Core Ideas: SC.HS.7.2.C Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	Crosscutting Concepts: <ul style="list-style-type: none"> • Cause and Effect • Stability and Change • Systems and System Models
Possible Preconceptions/Misconceptions: Students may not understand the importance of biodiversity or be able to see biodiversity in an ecosystem. Students may not be able to name or identify common plant and animal species found in the grasslands.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Animals Exploration:</u> Students will explore the Watch Prairie Animals page from Platte Basin Timelapse website. http://plattebasintimelapse.com/ed/chapter/wildlife/		
Individually, students will watch four videos of their choice. Once finished students will choose one animal to focus on and answer the following questions: <ul style="list-style-type: none"> • Which animal did you choose? • What is the animal’s role in the ecosystem? Is it a predator or prey species? • Where does the animal live? • What is an interesting fact about the animal? 		
EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i> <ul style="list-style-type: none"> • Computers with internet access • Paper • Pencil 		
<u>Grassland Animals Collection:</u> Students will create document collection of grassland animals. Students will research animal species native to the grasslands of Nebraska. Students will choose ten species to research and add to their collection. Students should choose a variety of species, including predator, prey, insect, etc. Students should choose a creative format to present their animal collection—can be a book or presentation. Students will need to follow the template below.		
Animal Collection Template: <ul style="list-style-type: none"> • Common and scientific name (<i>Genus species</i>) 		

- Image
- Native range (historical and current)
- habitat
- Species type (place in the food web)
- Food source
- Estimated population size
- Predators (if applicable)
- References

EXPLAIN: Concepts Explained and Vocabulary Defined:

Review the basic roles of an ecosystem.

Review lesson vocabulary.

Vocabulary:

Biodiversity- variety and variability of species in an ecosystem

Grassland- a large open area dominated by grasses

Ecosystem- a community of interacting organisms and their environment

ELABORATE: Applications and Extensions:

- **Grassland Biodiversity, Lesson Two:** Grassland Plants
- **Grassland Biodiversity, Lesson Three:** Grassland Food Web

EVALUATE:

Summative Assessment (Quiz / Project / Report): Animal Collection Project

At the end of the lesson, student will be able to:

1. Identify commonly found animal species in the grasslands of Nebraska
2. Identify an animal's role in the grassland ecosystem

Additional Resources:

Platte Basin Timelapse: <http://plattebasintimelapse.com>

Grasslands: <https://www.worldwildlife.org/habitats/grasslands>

Animals of the Northern Great Plains: <https://www.worldwildlife.org/stories/animals-of-the-northern-great-plains>

Wildlife and Agriculture: <http://plainshumanities.unl.edu/encyclopedia/doc/egp.ag.076>

Lesson Two: Grassland Plants

Grade/ Grade Band: 9-12	Topic: Earth Science/ Ecology	Lesson # 2 in a series of 3 lessons
<p>Brief Lesson Description: In this lesson, students will explore the biodiversity of Nebraska’s grasslands by researching plant species and creating an herbarium.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Identify native plants and animals commonly found in grasslands of Nebraska 2. Explain the factors that influence biodiversity 3. Construct and analyze a food web for a grassland ecosystem 		
<p>NGSS Standards: SC.HS.7 Interdependent Relationships in Ecosystems SC.HS.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic earth science background; knowledge of ecosystem interactions; knowledge of food webs</p> <p>From a distance, grasslands might just seem like a spreading grassy field, but that is not the case. Nebraska’s <u>grasslands</u> are a diverse <u>ecosystem</u> home to over 1,500 plant species. Each species plays a unique role in the ecosystem, with many animal species relying on these plants. However, grasslands are vulnerable to fragmentation and habitat loss. Understanding the unique ecosystem will allow for better management.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Asking Questions and Defining Problems • Developing and Using Models 	<p>Disciplinary Core Ideas: SC.HS.7.2.C Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Cause and Effect • Stability and Change • Systems and System Models
<p>Possible Preconceptions/Misconceptions: Students may not understand the importance of biodiversity or be able to see biodiversity in an ecosystem. Students may not be able to name or identify common plant and animal species found in the grasslands.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Grassland Plant Exploration</u>: Students will explore Prairie Plants page from the Platte Basin Timelapse website. http://plattebasintimelapse.com/ed/chapter/vegetation/</p> <p>Individually, students will watch the two videos on the webpage and explore the Prairie Plants Specimen section. While exploring the website students should think about the biodiversity of grassland plants. Once students are finished, lead a class discussion with the following questions:</p> <ul style="list-style-type: none"> • Why are plants important to an ecosystem? • Why are plants important to life on earth? • What factors influence where a plant might grow? • How would you describe the relationship between plants, animals, and insects? • How many grass species are found in Nebraska? 		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <u>Herbarium How-To</u>: As a class, review the process of creating an herbarium. There are three options for creating a class herbarium:</p> <ul style="list-style-type: none"> • Physical herbarium—students will follow the instructions listed on the student handout to collect real samples of grassland plants • Digital herbarium—students will use the plant specimen photos from Platte Basin Timelapse and other online sources • Photo herbarium—students will find real samples of grassland plants but taken detailed photos of the species <p>Timeframe, weather, and geographical location may be determining factors in this activity. It may not be entirely feasible for students to spend time searching for grassland species in nature, especially during the winter months. Students may not have the resources available to travel to a prairie to collect samples or have access to a camera to take photos.</p>		

Creating a physical herbarium with real samples collected by students will allow for the most in-depth activity. Students will explore the Plant Specimens section on the Platte Basin Timelapse website to become familiar with some grassland plant species. After students are familiarized with grassland plants, they will collect samples to be identified in the classroom. Students will then follow the instruction on the handout to preserve their plant samples.

A photo herbarium will also allow for a more in-depth activity. Students will follow the same steps as creating a physical herbarium, but without collecting or preserving samples.

A digital herbarium is the most accessible activity. If choosing this activity students should create a more in-depth report or presentation about the grassland species. Students will need to follow the template below.

Digital Herbarium Template:

- Image of the species
- Common name
- scientific name (*Genus species*)
- Family
- Native range (historical and current)
- Origin (native/exotic)
- Historical uses by humans
- Plant description

EXPLAIN: Concepts Explained and Vocabulary Defined:

Review the basic roles of an ecosystem.

Explain the factors that influence biodiversity.

Review lesson vocabulary.

Vocabulary:

Biodiversity- variety and variability of species in an ecosystem

Grassland- a large open area dominated by grasses

Ecosystem- a community of interacting organisms and their environment

Perennial- plant that completes its an entire life cycle, seed to flower to seed, in one growing season

Annual- plant that grows for multiple seasons

Biennial- plant that grows for two years before completing an entire life cycle, seed to flower to seed

Herbarium- a collection of preserved plants with associated data

ELABORATE: Applications and Extensions:

- **Grassland Biodiversity, Lesson Three:** Grassland Food web

EVALUATE:

Summative Assessment (Quiz / Project / Report): Student Herbarium

At the end of the lesson, students will be able to:

1. Explain the importance of grassland plants in an ecosystem
2. Identify commonly found grassland plants
3. Explain the factors that influence biodiversity of grassland plants

Additional Resources:

Wildflowers Terms- <https://aggie-horticulture.tamu.edu/wildseed/growing/annual.html>

NatGeo Grasslands- <https://www.nationalgeographic.com/environment/habitats/grasslands/>

Common Range Plants of Nebraska- <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1910&context=extensionhist>

Nebraska Plant Biodiversity- <http://outdoornebraska.gov/biodiversityplants/>

Forest Service Wildflowers- <https://www.fs.fed.us/wildflowers/index.shtml>

Grasses of Nebraska- <http://extensionpublications.unl.edu/assets/pdf/ec170.pdf>

Herbarium Plant Collection Instruction Sheet

Materials Needed:

- Scissors
- Gloves
- Zip closure plastic bag—used to store plant cuttings while in the field
- Newspaper to use in the drying process
- Enough cardboard for each plant specimen—each specimen needs two pieces of cardboard that are least 12x18 inches in size
- Heavy books to apply pressure during the drying process

*Note: it may be a good idea for educators and students to carry a first aid kit

How to Collect and Preserve Plant Specimens:

1. Find a location with an abundance native grassland plants—if it is on private land, be sure to get permission from the owner before entering on the property
2. Select plants that are in abundance—DO NOT collect specimens of species that are threatened or endangered
3. For small plants, collect the entirety of the plant from tip to root—be sure to include the stem, leaves, flowers, and roots
4. For large plants, collect only a small portion of the roots and tip—try to choose a stem with leaves and flowers if possible
5. Place plants in zip closure storage bags to keep from drying out—if it is a hot day or you are planning on being in the field for a long time, add a damp paper towel to further preserve the plants
6. After collection, create a plant pressing station for each specimen—each plant should be placed between pieces of newspaper and cardboard, then pressed with heavy books
7. Check plant specimens during the drying process—change out newspaper if it is damp
8. Once plants are dried, use online resources to identify the specimens
9. Glue plant specimens to large pieces of paper
10. Write a label on the specimen paper

The Plant Specimen Label should include:

- Scientific name (genus, species)
- Common name
- Family
- Origin (native/exotic)
- Collection location (state, county)
- Site notes
- Date collected
- Collector name

Lesson Three: Grassland Food Web

Grade/ Grade Band: 9-12	Topic: Earth Science	Lesson # 3 in a series of 3 lessons
Brief Lesson Description: In this lesson, students will connect their knowledge of grassland plant and animal biodiversity by creating a food web		
Performance Expectation(s): Students will be able to: <ol style="list-style-type: none"> 1. Identify native plants and animals commonly found in grasslands of Nebraska 2. Explain the factors that influence biodiversity 3. Construct and analyze a food web for a grassland ecosystem 		
NGSS Standards: SC.HS.7 Interdependent Relationships in Ecosystems SC.HS.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.		
Narrative / Background Information		
Prior Student Knowledge: Basic earth science background; knowledge of ecosystem interactions; knowledge of food webs From a distance, grasslands might just seem like a spreading grassy field, but that is not the case. Nebraska’s <u>grasslands</u> are a diverse <u>ecosystem</u> home to thousands of animal and plant species. Both plant and animal species play a unique role in the ecosystem. <u>Food chains</u> and <u>food webs</u> can be used to model the interdependence of species in an ecosystem. It is important to consider how species rely on another when making ecosystem management decisions. While grasslands are highly diverse, they are vulnerable to fragmentation and habitat loss.		
Science & Engineering Practices: <ul style="list-style-type: none"> • Asking Questions and Defining Problems • Developing and Using Models 	Disciplinary Core Ideas: SC.HS.7.2.C Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem	Crosscutting Concepts: <ul style="list-style-type: none"> • Cause and Effect • Stability and Change • Systems and System Models
Possible Preconceptions/Misconceptions: Students may not understand the importance of biodiversity or be able to see biodiversity in an ecosystem. Students may not be able to name or identify common plant and animal species found in the grasslands.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: Background Lecture: Review the components of a food web, food chain, and ecosystem in a brief background lecture. Food Web Activity: Students will read through the background information on food chains and food webs, then complete the food chain activity on the Platte Basin Timelapse website http://plattebasintimelapse.com/ed/chapter/activities-food-chain-food-web/		
EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: Lesson Materials & Preparations: <ul style="list-style-type: none"> • Computers with internet access • Paper • Pencil • Colored pencils/markers • Construction paper <p>Before the lesson, prepare a brief background lecture on the components of a food web, food chain, and ecosystem</p>		
Grassland Food Web Model: Students will create their own food web model of a grassland ecosystem. Students should include some of the plants and animals they research in previous lessons. The food web should be very detailed and include written explanation as needed. Food Web Components: <ul style="list-style-type: none"> • Energy source • Producers • Consumers 		

- Decomposers

After students have finished their food web model, they will briefly present it to the class. Students should be able to provide an explanation of all the included components.

Wrap Up Discussion: Lead a class discussion to wrap up the lessons.

Use the following questions to guide discussion:

- What are the main components of an ecosystem?
- What are the main components of a food web/chain?
- What factors influence biodiversity?
- What did you learn about grassland biodiversity?
- What is your opinion on grassland ecosystems after these lessons?

EXPLAIN: Concepts Explained and Vocabulary Defined:

Explain the basic components of an ecosystem.

Review the basic components of a food web/chain.

Review lesson vocabulary.

Vocabulary:

Biodiversity- variety and variability of species in an ecosystem

Grassland- a large open area dominated by grasses

Ecosystem- a community of interacting organisms and their environment

Food Chain- a linear model demonstrating how organisms are related by the food consumed

Food Web- a system of food chains, demonstrating how organisms interact and depend on one another based on the food consumed

ELABORATE: Applications and Extensions:

- **Biosphere, Floral and Faunal Resources**
- **Biosphere, Eastern Redcedar Invasion**
- **Atmosphere, Earth's Atmosphere:** Matter and Energy Interactions in the Grasslands

EVALUATE:

Formative Monitoring (Questioning / Discussion): Wrap Up Discussion

At the end of the lesson, students will be able to:

1. Explain a food web and food chain for a grassland ecosystem
2. Identify the factors that influence biodiversity
3. Explain The main components of an ecosystem

Additional Resources:

USGS Food Web- <https://www.camnl.wr.usgs.gov/isoig/projects/fingernails/foodweb/definition.html>

American Prairie Food Web- <https://www.exploringnature.org/db/view/American-Prairie-Food-Web>

Nebraska Prairie- <https://prairienebraska.org>

Geosphere



Geosphere

This packet contains two sections with five lessons to explore the geological resource of America's grasslands.

The Geosphere is the solid parts of Earth composed of rocks, minerals, and soils. While all of Earth's spheres are critical to life, the Geosphere is especially important because it contains the medium necessary for plant, animal, and human life. Grassland soils are one of the most valuable resources in the Great Plains because of the abundance of organic matter. Soil science and geology are directly related because many soil characteristics are determined by the underlying parent material or bedrock. Soils may also be influenced by geographic location, topography, and organic matter content. While all soils may seem similar at first glance, they are highly diverse and unique. In the state of Nebraska, there are 385 different soil types grouped into 31 associations based on the geographic location. Understanding the soil and geological structure of an area is important for a number of reasons. Soil and geology can directly impact the land use ability because some soils are suited for building or agricultural use. Additionally, humans rely on rocks and minerals for daily life, and minerals, such as salt, are essential to survival. Most of these necessary minerals are obtained by humans through the food consumed. However, there are other important minerals and rocks that are only obtained through mining the Earth's surface. Geologists often work closely with natural resource managers, soil scientists, archaeologists, and paleontologists. Each of these fields are closely interconnected and rely on one-another.

Sections:

1. Soil Investigation
 - Soil Science Introduction
 - Porosity and Permeability
2. Geological Time in the Oglala National Grasslands
 - The Rock Cycle
 - Layer Formation
 - Grassland Geology

Soil Investigation

This packet contains two lessons to explore the fertile soil of America's grasslands. In these lessons, students will be introduced to the basics of soil science by modeling a soil profile, testing the permeability and porosity of soil, and conducting an online grassland soil survey. Lessons are geared towards grades 9-12.

In the very basic form, soil is composed of organic matter, organisms, minerals, gases, and liquids. Soil is important to life on Earth because it acts as a medium to grow food and build shelters. It is important to understand the complexity of soil science and to promote healthy soils because it plays such an important role in ecosystems. Human activities, such as farming and mining, can cause long term damage to soil. Understanding the formation and properties of the soil can help to mediate such damage.¹ Soil is primarily composed of minerals, which originate from weathered rock, called parent material.¹ The source of the parent material can come from a number of locations. Sometimes the parent material is the bedrock directly below the soil, or sometimes the material is transported from a different location by processes such as glaciation or wind.¹ The parent material of the soil influences many soil characteristics. Organic matter content, geographic location, and topography also influence soil characteristics. Topsoil is considered the most fertile soil layer and the grasslands of the United States have produced some of the most fertile soils. The fertile soil of grasslands is due to the decomposition of grass roots and surface vegetation. Such organic matter is incorporated into the top layer of the soil by burrowing animals.² Soils are characterized by color, texture, structure, and consistence.² In the state of Nebraska, there are 385 different soil series, which can be grouped into 31 associations based different geographic locations.² Soil is one of Nebraska's most valuable natural resources, so it is important to understand the science and promote conservation practices.

References:

1. Fox, H.E., Cunningham, R.L., & Shipp, R.F. (1993). Some Facts about Soil Basics. PennState Extension. Retrieved from <https://extension.psu.edu/some-facts-about-soil-basics>
2. Nebraska Soils. (n.d.). School of Natural Resources Conservation and Survey Division. University of Nebraska-Lincoln. Retrieved from <https://snr.unl.edu/csd/soil/nebraskasoils-learnmore.aspx>

Lessons:

1. Soil Science Introduction
 - Background introduction to soil science basics
 - Soil profile modeling—students will draw a model of a soil core, labeling the different soil horizons
2. Porosity and Permeability
 - Background and Lesson One review
 - Porosity and Permeability video
 - Porosity Lab—students will test the porosity of three soil types
 - Permeability Lab—students will test the permeability of three soil types

Lesson One: Soil Science Introduction

Grade/ Grade Band: 9-12	Topic: Geology/ Earth Science	Lesson # 1 in a series of 3 lessons
Brief Lesson Description: In this lesson, students will be introduced to the science of soils, learn about different soil types, and identify the importance of soil.		
Performance Expectation(s): Students will be able to: <ol style="list-style-type: none"> 1. Identify three basic soil particle classifications (clay, sand, silt) 2. Identify the layers of soil 3. Explain parent material and how soil is formed 		
NGSS Standards: SC.HS.13 Earth's Systems SC.HS.13.3 Gather, analyze, and communicate evidence to defend the position that Earth's systems are interconnected and impact one another.		
Narrative / Background Information		
Prior Student Knowledge: Basic geology and Earth science background; This lesson will serve as an introduction to soil science		
<p><u>Soil</u> is composed of organic matter, organisms, minerals, gases, and liquids. Soil is important to life on Earth because it acts as a medium to grow food and build shelters. Human activities, such as farming and mining, can cause long term damage to soil. Understanding the formation and properties of the soil can help to mediate such damage. Soil is primarily composed of minerals, which originate from weathered rock, called <u>parent material</u>. The source of the parent material can come from a number of locations. Sometimes the parent material is the bedrock directly below the soil, or sometimes the material is transported from a different location by processes such as glaciation or wind. The parent material of the soil influences many soil characteristics. Organic matter content, geographic location, and topography also influence soil characteristics. Soils are characterized by color, texture, structure, and consistence.</p>		
Science & Engineering Practices: <ul style="list-style-type: none"> • Asking Questions and Defining Problems • Obtaining, Evaluating, and Communicating Information 	Disciplinary Core Ideas: C.HS.13.3.A Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.	Crosscutting Concepts: <ul style="list-style-type: none"> • Structure and Function • Systems and System Modeling
Possible Preconceptions/Misconceptions: Students may not know that soil is a diverse living medium. Students may think that soil and dirt are the same thing. Students may not know about the different types of soil or soil characteristics.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <i>Lesson Materials & Preparations:</i> <ul style="list-style-type: none"> • Paper • Pencil • Computer with internet access • Background presentation Before the lesson, prepare a background presentation, including the images in the lesson materials section		
<hr/> Opening Discussion: Use the following questions to guide class discussion. <ul style="list-style-type: none"> • What is soil? • What is soil used for? • Why is soil important? • How is soil formed? • How do humans interact with soil? 		
Background Presentation: Provide students will the background information, showing the images in the lesson materials (soil core, soil horizons, soil triangle)		
EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: Soil Profiles Video: Students will watch this soil profiles video from Purdue University Extension https://www.youtube.com/watch?v=xoTd7ctj-e0		
Soil Profile Modelling: Students will look at a soil core image. Students will draw a model of a soil core and label each soil horizon. Students		

will identify the main characteristics of the soil layer.

Class Discussion: Use the following questions to guide class discussion.

- What are the three basic types of soil? Are those the only soil types?
- How do soils differ by location in the United States? Provide an example.
- What is parent material?
- How is soil formed?
- Why are some soils more suitable for farming?
- Why are some soils more suitable for building?

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Explain the roll soil plays in an ecosystem.

Vocabulary:

Soil- Mineral or organic material on the immediate surface of Earth, a natural medium for terrestrial plants to grow

Soil horizon- Layers of soil

Soil profile- Visible cross section, showing the soil horizons

Parent material- Underlying rock material, which forms soil horizons

ELABORATE: Applications and Extensions:

- **Grassland Soil Investigation, Lesson Two:** Porosity and Permeability
- **Grassland Soil Investigation, Lesson Three:** Nebraska Soil Survey

EVALUATE:

Formative Monitoring (Questioning / Discussion): Soil Profile Modeling/ Class Discussions

At the end of the lesson, students will be able to:

1. Identify and label the characteristics of soils horizons
2. Explain how soil is formed
3. Identify the three basic particle types of soil (clay, sand, silt)

Additional Resources:

NRCS Soils- <https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/edu/7thru12/>

NRCS Soil Profile- https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054308

Nebraska Soils- <https://snr.unl.edu/csd/soil/nebraskasoils-learnmore.aspx>

NASA Soil Profile Activity- <https://myasadata.larc.nasa.gov/lesson-plans/create-your-own-soil-profile-activity>

Soil Profile Video- <https://www.youtube.com/watch?v=xoTd7ctj-e0>

Lesson Two: Porosity and Permeability

Grade/ Grade Band: 9-12	Topic: Geology/ Earth Science	Lesson # 2 in a series of 3 lessons
<p>Brief Lesson Description: In this lesson, students will explore how water moves through different types of soil. Students will be introduced to the concept of porosity and permeability by participating in a hands-on demonstration.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Define porosity and permeability 2. Explain why water moves through different soils at different rates 		
<p>NGSS Standards: SC.HS.13 Earth's Systems SC.HS.13.3 Gather, analyze, and communicate evidence to defend the position that Earth's systems are interconnected and impact one another.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Soils background from lesson one; Basic water cycle background</p> <p><u>Soil</u> is composed of organic matter, organisms, minerals, gases, and liquids. Soil is important to life on Earth because it acts as a medium to grow food and build shelters. There are hundreds of different soil types all based on around three basic particle types: clay, sand, and silt. The type of soil influences how much water can be held and how quickly water moves through the soil. Between soil particles are open spaces called <u>pores</u>. Soil texture and conditions, such as compactness and organic matter, influence <u>porosity</u>. The soil <u>permeability</u> is also affected by texture and porosity.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> ● Asking Questions and Defining Problems ● Obtaining, Evaluating, and Communicating Information 	<p>Disciplinary Core Ideas: SC.HS.13.3.D Plan and conduct an investigation of the properties of water and their effects on Earth materials, surface processes, and groundwater systems.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> ● Structure and Function ● Systems and System Modeling
<p>Possible Preconceptions/Misconceptions: Students may not know what porosity or permeability are. Students may not understand how soil characteristics influence water.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> ● Paper ● Pencil ● Markers ● Computer with internet access ● Background materials from Lesson One: Soil Science Introduction ● Three soil types (sand, gravel, clay, potting soil, etc.) ● Clear plastic cups (large size)—enough for three cups for each group ● Clear plastic cups with holes in the bottom—enough for three cups for each group ● Graduated cylinders ● Beakers ● Food coloring ● Stopwatch/ timer ● Calculator ● Porosity/ Permeability activity worksheets <p>Print out enough activity worksheets for each student. Prepare porosity and permeability activity materials for groups for quicker assembly.</p>		
<p><u>Background & Lesson One Review</u>- Review the background materials and takeaways from Lesson One: Soil Science Introduction. Students will review their soil profile model. Provide students with background information and lesson vocabulary.</p>		
<p><u>Porosity and Permeability Video</u>- Students will watch the following porosity and permeability background video https://www.youtube.com/watch?v=8mfBomrw0rs</p>		

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:

Porosity Lab- Provide students with the porosity activity instruction sheet (located in lesson materials). Students will conduct the porosity activity using three different soil types. Students will record their hypothesis first, then test their hypothesis. Students should write their results in the table provided on the worksheet.

Permeability Lab- Provide students with the permeability activity instruction sheet (located in lesson materials). Students will conduct the permeability activity using three different soil types. Students will record their hypothesis first, then test their hypothesis. Students should write their results in the table provided on the worksheet. Students should turn in their lab worksheets.

Discussion- Use the following questions to guide class discussion.

- What is porosity?
- What is permeability?
- Which soil had the highest porosity? And the lowest?
- Which soil had the highest permeability? And the lowest?
- How does porosity and permeability influence groundwater?

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Explain the difference between porosity and permeability.

Review lesson vocabulary.

Vocabulary:

Soil- Mineral or organic material on the immediate surface of Earth, a natural medium for terrestrial plants to grow

Soil Pores- Open space between soil particles

Porosity- The amount of pores between soil particles

Permeability- The property of soil that allows water to move through it

ELABORATE: Applications and Extensions:

- **Grassland Soil Investigation, Lesson Three:** Grassland Soil Survey

EVALUATE:

Summative Assessment (Quiz / Project / Report): Porosity and Permeability Activity

At the end of the lesson, students will be able to:

1. Define porosity and permeability
2. Calculate percent porosity of three soil samples
3. Explain why water moves through soil at different rates

Additional Resources:

Soil Permeability- http://www.fao.org/tempref/FI/CDrom/FAO_Training/FAO_Training/General/x6706e/x6706e09.htm

Soil Porosity- <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/soil-porosity>

Nebraska Soils- <https://snr.unl.edu/csd/soil/nebraskasoils-learnmore.aspx>

Soil Science- <https://www.soils.org/about-soils>

Porosity and Permeability Lab

Materials Needed

- Three large plastic cups without holes
- Three large plastic cups with holes (permeability lab)
- Three different soil types (200 mL of each)
- Graduated cylinder
- Beaker
- Water
- Food coloring
- Timer
- Calculator

Porosity Lab Instructions

1. Collect three soil types
2. Using the beaker, measure 100 mL of each soil, add to cups *without holes*
3. Mark the top of the soil level with a marker, label 100 mL
4. Fill graduated cylinder with 100 mL of water, add food coloring
5. Pour water into soil, stop when the water level reaches the 100 mL mark
6. Record the amount of water left in the graduate cylinder in table
7. Calculate pore space by subtracting the amount of water left in the cylinder from the original 100 mL
8. Repeat steps 2 through 7 for each additional soil
9. Calculate percent porosity for each soil type using the formula on the worksheet

Permeability Lab Instructions

1. Collect three soil types
2. Using the beaker, measure 100 mL of each soil, add to cups *with holes*
3. Fill graduated cylinder with 100 mL of water, add food coloring
4. Get a stopwatch ready to time the water movement
5. Have one partner hold the cup over the beaker (the water will run through the cup into the beaker)
6. Quickly pour the 100 mL of water into the soil sample, begin timing as soon as the water hits the soil
7. Stop timing as soon as water begins to drip out of the bottom
8. Record how long it took for water move through the soil sample
9. Repeat steps 2 through for each additional soil

Porosity and Permeability Lab Student Worksheet

Name:

1. Hypotheses—write your hypothesis for which soil type will have the highest porosity, lowest porosity, highest permeability, and lowest permeability.

2. Record your Porosity and Permeability Lab data in the table below.

Soil Type	Total Water Volume (mL)	Water Volume Left in Cylinder (mL)	Pore Space Volume (water total-water left)	Percent Porosity (%)	Permeability (Seconds)

Percent Porosity= (volume of pore space/ volume of material) x 100

Example: 44 mL of water pour into the soil sample, leaving 66 mL in the cylinder. $100-66= 44$ mL

Percent Porosity= $(44/100) \times 100= 44\%$

Geological Time in the Oglala National Grasslands

This packet contains three lessons for students to explore how rocks are formed, layers are aged, and the unique geological resources of the Oglala National Grasslands. Lessons are geared towards grades 9-12.

Located in northwestern Nebraska, the Oglala National Grasslands is a 94,000-acre mixed grass prairie with many unique geological features.¹ Toadstool Geologic Park is named for its unusual geological formations in the shape of toadstools. This area has a unique history preserved in stone dating back approximately 30 million years.² Geologists use a few different methods to determine the age of rock formations, archaeological artifacts, and fossils. One such method is called relative rock dating, which doesn't provide an exact age, but rather a relative age based on the layers of rock. Relative rock dating relies on three basic principles: The Law of Superposition, the Law of Cross-cutting, and the Law of Inclusions. Each of these three Principles helps geologists determine an approximate age based on the order and layer of each rock formation. In these lessons, students will demonstrate relative rock dating and create a geologic timeline in the Oglala National Grasslands.

References:

1. Oglala National Grasslands, U.S. Forest Service. Retrieved from: <https://www.fs.usda.gov/rea/ncra/nebraska/rea/?recid=30328>
2. Time Travel through Toadstool Geologic Park, U.S. Forest Service. Retrieved from: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm9_028040.pdf

Lessons:

1. The Rock Cycle:
 - Class Discussion
 - Introduction Lecture
 - Rock investigation activity—students will describe the color, texture, shape, and smell of igneous, sedimentary, and metamorphic rock samples
 - Rock Cycle modeling activity—students will draw a model of the rock cycle and explain how rocks are formed
2. Layer Formation:
 - Layer formation activity—students will use clay to demonstrate the relative age relationship of rocks
 - Cross-section diagram examination—students will look at cross-section diagrams to determine the relative age and sequence of rock formations
3. Grassland Geology:
 - Background research—students will perform a background research on the geology of the Oglala National Grassland
 - Grassland timeline activity —students will develop a geologic timeline specific to the Oglala National Grassland

The Rock Cycle

Grade/ Grade Band: 9-12	Topic: Geology/ Earth Science	Lesson # 1 in a series of 3 lessons
Brief Lesson Description: In this lesson, students will be introduced to the rock cycle and explore how rocks and soils are formed.		
Performance Expectation(s): Students will be able to: <ol style="list-style-type: none"> 1. Identify the three primary rock types 2. Create a rock cycle model 3. Explain how rocks and soils are formed 		
NGSS Standards: SC.HS.14 History of Earth SC.HS.14.4 Gather, analyze, and communicate evidence to interpret Earth's history.		
Narrative / Background Information		
Prior Student Knowledge: Basic geology background; Basic earth science background <u>Geology</u> is the study of physical structure and substance of Earth and the processes that act on it. Geology primarily focuses on rocks, minerals, and soils. Understanding the processes that act on rocks can be beneficial when studying other disciplines including archaeology and paleontology. There are three primary types of rocks: <u>igneous</u> , <u>metamorphic</u> , and <u>sedimentary</u> . Igneous rocks are formed by cooled magma or lava. Sedimentary rocks are formed by the cementation of sediment on the floor of the ocean or another body of water. Metamorphic rocks are formed by a transformation from one of the other rock types under extreme heat or pressure. The process of rock formation and transformation is called the <u>rock cycle</u> .		
Science & Engineering Practices: <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	Disciplinary Core Ideas: SC.HS.14.4.A Evaluate evidence of <u>the past and current movements</u> of continental and oceanic crust and the theory of plate tectonics to explain the <u>differences in</u> age, structure, and composition of crustal and sedimentary rocks.	Crosscutting Concepts: <ul style="list-style-type: none"> • Cause & effect • Patterns • Geology • Earth Science
Possible Preconceptions/Misconceptions: Students may not have much knowledge of geologic processes or how rocks are formed. Students may not have thought about how or why rocks are structurally different or aged differently.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Class Discussion-</u> Ask students the following questions to gauge knowledge of the subject. It is okay if students don't know much about the subject. This is an introductory lesson to provide geology basics. Discussion questions: <ul style="list-style-type: none"> • What is a rock? • Are there different types or rocks? How do you know? • How are rocks formed? • How is soil formed? • What do rocks and soil have in common? • What can we learn by studying geology? 		
<u>Background Lecture-</u> Review the rock cycle and three basic rock types. Be sure to provide students with a visual of the rock cycle and examples of igneous, sedimentary, and metamorphic rocks.		
EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i> <ul style="list-style-type: none"> • Background lecture • Computers with internet access • Paper • Pencil • Colored pencil/markers • Igneous, sedimentary, and metamorphic rock samples Before the lesson, prepare a brief background lecture reviewing the rock cycle and three rock types. Number each rock sample for the Rock		

Investigation activity. Be sure to keep track of which sample corresponds to each number, but don't share with the students.

Rock Investigation- Students will use their senses to investigate igneous, metamorphic, and sedimentary rock samples. Students should describe the color, texture, smell, and shape of different rock samples. Students don't have to positively identify whether or not the rocks are igneous, metamorphic, or sedimentary, but should write down their observations for each sample and make a guess at the rock type. The point of this activity is to excite students and get them thinking about the different characteristics of rocks.

Rock Cycle Modeling- Following the class discussion and lecture, students will create their own rock cycle model. Students should be creative and include examples of different rock types. Students should label the model and prepare a brief (less than 5-minute) presentation of their model for the class.

Class Discussion- Revisit the questions from the beginning of the class.

Discussion questions:

- What is a rock?
- Are there different types of rocks? How do you know?
- How are rocks formed?
- How is soil formed?
- What do rocks and soil have in common?
- What can we learn by studying geology?

EXPLAIN: Concepts Explained and Vocabulary Defined:

Review the rock cycle.

Review rock types.

Review lesson vocabulary.

Vocabulary:

Geology- science that focuses on the physical structure and substance of the earth, and the processes that act on it

Rock Cycle- the processes that create and transform the rocks in Earth's crust

Igneous- magmatic rock formed through the cooling and solidification of lava or magma

Metamorphic- rock formed by the transformation of existing rock types under extreme heat and pressure

Sedimentary- rock formed by the accumulation or deposition of small particles or sediment and cementation on the ocean floor or in another body of water

ELABORATE: Applications and Extensions:

- **Geological Time in the Oglala National Grassland, Lesson Two:** Layer Formation
- **Geological Time in the Oglala National Grassland, Lesson Three:** Grassland Geology

EVALUATE: Formative Monitoring (Questioning / Discussion): Class Discussion/ Rock Cycle Model

At the end of the lesson, students will be able to:

1. Explain how rocks are formed
2. Identify the three main rock types
3. Describe the rock cycle in their model

Additional Resources:

Rock Cycle Video: https://youtu.be/pm6cCg_Do6k

The Rock Cycle: <https://www.nationalgeographic.org/encyclopedia/rock-cycle/>

Igneous Rocks: <https://geology.com/rocks/igneous-rocks.shtml>

Sedimentary Rocks: <https://geology.com/rocks/sedimentary-rocks.shtml>

Metamorphic Rocks: <https://geology.com/rocks/metamorphic-rocks.shtml>

Layer Formation

Written by Jessica Dickinson, adapted by Emily Reif

Grade/ Grade Band: 9-12	Topic: Geology/Earth Science	Lesson # 2 in a series of 3 lessons
Brief Lesson Description: In this lesson, students will explore the relative age and sequence of rock formations.		
Performance Expectation(s): Students will be able to: <ol style="list-style-type: none"> 1. Research and evaluate geological formations to explain the difference in age, structure, and composition 2. Communicate how relative rock dating can be used to identify the age of rock formations 		
NGSS Standards: SC.HS.14 History of Earth SC.HS.14.4 Gather, analyze, and communicate evidence to interpret Earth's history.		
Narrative / Background Information		
Prior Student Knowledge: Basic geology background; Basic earth science background <u>Geology</u> is the study of physical structure and substance of Earth and the processes that act on it. Geology primarily focuses on rocks, minerals, and soils. Understanding the processes that act on rocks can be beneficial when studying other disciplines including archaeology and paleontology. Scientists use different methods to date artifacts, fossils, and rocks. One such method is called relative rock dating, which doesn't provide an exact age, but rather a relative age based on the layers of rock. Relative rock dating relies on three basic principles: The <u>Law of Superposition</u> , the <u>Law of Cross-cutting</u> , and the <u>Law of Inclusions</u> . Each of these three Principles helps geologists determine an approximate age based on the order and layer of each rock formation.		
Science & Engineering Practices: <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	Disciplinary Core Ideas: SC.HS.14.4.A Evaluate evidence of <u>the past and current movements</u> of continental and oceanic crust and the theory of plate tectonics to explain the <u>differences in</u> age, structure, and composition of crustal and sedimentary rocks.	Crosscutting Concepts: <ul style="list-style-type: none"> • Cause & effect • Patterns • Geology • Earth Science
Possible Preconceptions/Misconceptions: Students may not have much knowledge of geologic processes, or how rocks are aged. Students may not have thought about how or why rocks are different ages.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Relative Rock Dating video-</u> Before beginning the lesson, students will watch the following video on process of relative rock dating. https://www.youtube.com/watch?v=M2Ex5DljtU		
<u>Layer formation activity-</u> Students will use clay to demonstrate the principles of relative age relationships in rock formations. Provide each student with three different colors of clay. Students will create a rock formation using the different colors of clay. Students will demonstrate the Law of Superposition and explain which layers of rock are the oldest and youngest.		
EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i> <ul style="list-style-type: none"> • Clay of difference colors • Relative Rock Dating student worksheets <p>Print out student worksheets</p>		
<hr/> <u>Cross-section Examination activity-</u> Students will examine geologic cross-section and identify different layers and age based on the Law of Superposition. To begin, students will research geologic formations with many layers. Students will choose a formation to investigate and take notes on. Following the brief research, students will complete the relative dating worksheet.		
EXPLAIN: Concepts Explained and Vocabulary Defined: Answer student questions. Explain relative rock dating principles. Clarify that relative rock dating does not provide an exact age.		

Review lesson vocabulary.

Vocabulary:

Geology- science that focuses on the physical structure and substance of the earth, and the processes that act on it

Law of superposition- states that in any undisturbed sequence of rocks deposited in layers, the youngest layer is on the top and the oldest layer is on the bottom

Law of crosscutting- states that the geologic feature which cuts through another is the younger of the two layers

Law of inclusions- states that inclusions in a geologic feature are older than the rock encasing it

ELABORATE: Applications and Extensions:

- **Geological Time in the Oglala National Grassland, Lesson Three:** Grassland Geology

EVALUATE:

Summative Assessment (Quiz / Project / Report): Relative rock dating activity and worksheet

At the end of the lesson, students will be able to:

1. Explain how different layers of rocks are formed and why they are different ages
2. Identify differences in age of geologic formations using relative dating principles

Elaborate Further / Reflect: Enrichment:

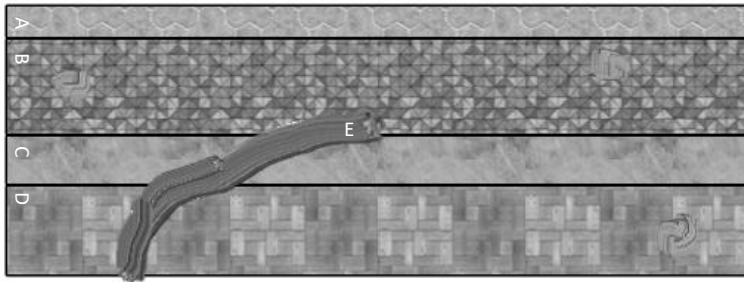
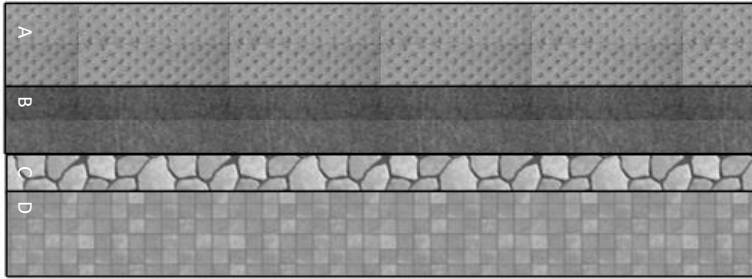
Relative Dating video: <https://www.youtube.com/watch?v=g7Nh1ABk-FE>

Dating Rocks and Fossils: <https://www.nature.com/scitable/knowledge/library/dating-rocks-and-fossils-using-geologic-methods-107924044/>

What is Geology?: <https://geology.com/articles/what-is-geology.shtml>

Relative Rock Dating Worksheet

Determine which layers are oldest and youngest using relative rock dating principles



Grassland Geology

Written by Jessica Dickinson, adapted by Emily Reif

Grade/ Grade Band: 9-12	Topic: Geology/Earth Science	Lesson # 3 in a series of 3 lessons
Brief Lesson Description: In this lesson, students will explore the geological history of the Oglala National Grassland by creating a geology timeline.		
Performance Expectation(s): Students will be able to: <ol style="list-style-type: none"> 1. Develop a model to illustrate the geologic history of the Oglala National Grassland 2. Identify how geologic processes shaped and changed the landscape of the Oglala National Grassland 		
NGSS Standards: SC.HS.14 History of Earth SC.HS.14.4 Gather, analyze, and communicate evidence to interpret Earth’s history.		
Narrative / Background Information		
Prior Student Knowledge: Basic geology background; Basic earth science background; Relative rock dating principles from lesson one		
<p>Located in northwestern Nebraska, the Oglala National Grasslands is a 94,000-acre mixed grass prairie with many unique geological features. Toadstool Geologic Park is named for its unusual geological formations in the shape of toadstools. This area has a unique history preserved in stone dating back approximately 30 million years. <u>Geology</u> is the study of physical structure and substance of Earth and the processes that act on it. Geology primarily focuses on rocks, minerals, and soils. Understanding the processes that act on rocks can be beneficial when studying other disciplines including archaeology and paleontology. Scientists use different methods to date artifacts, fossils, and rocks. One such method is called relative rock dating, which doesn’t provide an exact age, but rather a relative age based on the layers of rock. Geologic time provides a timeline for the Earth and is separated into different periods. <u>Geologic Periods</u> are subdivisions of geologic time, used to cross-reference rocks and geologic events. These periods typically reflect the changes to natural patterns and Earth’s history, such changes can be seen when looking at the plants and animals alive during that period.</p>		
Science & Engineering Practices: <ul style="list-style-type: none"> • Evaluate Evidence • Apply Scientific Reasoning • Ask Questions & Define Problems 	Disciplinary Core Ideas: SC.HS.14.4.A <u>Evaluate evidence of the past and current movements</u> of continental and oceanic crust and the theory of plate tectonics to explain the <u>differences in</u> age, structure, and composition of crustal and sedimentary rocks. SC.HS.14.4.B Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to reconstruct Earth’s formation and early history. SC.HS.14.4.C Develop a model to illustrate how Earth’s internal and surface processes operate over time to form, modify, and recycle continental and ocean floor features	Crosscutting Concepts: <ul style="list-style-type: none"> • Cause & effect • Patterns • Geology • Earth Science
Possible Preconceptions/Misconceptions: Students may not know anything about the Oglala National Grassland. Students might not think of the grasslands as an interesting geologic location. Students may not know the different geologic periods or what that means.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Class Review</u> - Review relative rock dating, and the three laws covered in lesson one. Provide students with background information.		
<u>Background Research</u> - Separate students into groups of two or three. Assign a geologic period to each group. Each group will conduct background research on geology of the Oglala National Grassland Research should answer the following questions: <ul style="list-style-type: none"> • Is there evidence of your geologic period in the rock record? (i.e., surface or subsurface) • What is known about your geologic period? • What were climate conditions like during your geologic period? 		

- What fossils are found from your geologic period?
- What can you infer about the environment based on the climate and fossils from your geologic period?

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:

Lesson Materials & Preparations:

- Butcher paper (approximately 35 ft)
- Paper
- Pencil
- Colored pencils/markers

Measure and cut approximately 35 feet of butcher paper. Draw lines and label each geologic time period according to the following table:

Geologic Period	Start of Period	Distance from Origin to Mark on Paper	
	Millions of years ago	Feet	Inches
Cambrian	544	5.44	65
Ordovician	505	5.05	61
Silurian	440	4.40	53
Devonian	410	4.10	49
Carboniferous	360	3.60	43
Permian	286	2.86	34
Triassic	248	2.48	30
Jurassic	213	2.13	26
Cretaceous	145	1.45	17
Tertiary	65	0.65	8
Quaternary*	1.8	0.08*	1*

*Note: The quaternary period was rounded up to 1 inch.

Optionally, a timeline break could be used to give students extra space to work.

Geologic Timeline- After completing the background research, groups will draw a visual representation of their geologic time period. Each group will fill in their geologic time period on the butcher paper. Groups should prepare a short presentation on their geologic time period to be presented to the class during the timeline walk.

The timeline and presentation should include:

- Plants life found during that period
- Animal life found during that period
- Environmental conditions
- Climate conditions
- When the geologic period occurred

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Explain the concept of geologic periods and epochs.

Review lesson vocabulary.

Vocabulary:

Geology- Science that focuses on the physical structure and substance of the earth, and the processes that act on it

Geologic Period- A subdivision of geologic time, used to cross-reference rocks and geologic events

ELABORATE: Applications and Extensions:

- Grassland Soil Investigation, Lesson One: Soil Science Introduction
- Grassland Soil Investigation, Lesson Two: Porosity and Permeability
- Grassland Soil Investigation, Lesson Three: Soil Survey

EVALUATE:

Summative Assessment (Quiz / Project / Report): Geologic timeline activity and presentation

At the end of the lesson, students will be able to:

1. Illustrate the geologic history of the Oglala National Grassland

2. Explain the history of one geologic time period

Elaborate Further / Reflect: Enrichment:

PaleoPortal: http://www.paleoportal.org/kiosk/sample_site/time_space.html

Climate History: <http://www.scotese.com/climate.htm>

Oglala National Grassland: <https://www.fs.usda.gov/recarea/nebraska/recarea/?recid=30328>

Oglala National Grassland Britannica: <https://www.britannica.com/place/Oglala-National-Grassland>

Toadstool Geologic Park: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm9_028040.pdf

How are Geological Periods Determined: <https://www.geolsoc.org.uk/Education-and-Careers/Ask-a-Geologist/Nomenclature/How-are-Geological-Periods-Determined>

Hydrosphere



Hydrosphere

This packet contains two sections with five lessons to explore the movement of water in the Grasslands of the United States.

The hydrosphere contains all the water on Earth's surface, underground, held in ice, and in the atmosphere. The hydrosphere covers approximately 70 percent of the Earth's surface, most of which is in the oceans. The liquid water available on Earth helps to make the planet habitable because water is essential for supporting life. The water on Earth is in constant circulation between different reservoirs a process called the hydrologic cycle. During this cycle, water moves through all of Earth's spheres and plays a major role in each. Underneath the Great Plains is one of the largest aquifers. The Ogallala Aquifer lies underneath approximately 174,000 square miles of lands and stretches from South Dakota to Texas. This water source plays an important role in the ecosystem and culture of the Great Plains. The Ogallala Aquifer supports surface waters such as lakes and streams, plant and animal life, and humans. However, the Ogallala Aquifer, like many other water sources, is in danger due to depletion and pollution. Understanding how water moves through Earth's sphere is critical for long-term sustainable management.

Sections:

1. Hydrosphere Basics
 - Water Cycle
 - Water Table
2. Ogallala Aquifer
 - Renewable or Non-Renewable?
 - Ogallala Aquifer Recharge
 - Water Allocation Roundtable

Hydrosphere Basics

This section contains two lessons to explore the basics of Earth's hydrosphere by creating a water cycle diagram in a grassland ecosystem and modeling the Ogallala Aquifer using a water table demonstration. Lessons are geared towards grades 9-12.

Earth's hydrosphere contains all the water on Earth's surface, underground, held in ice, and in the atmosphere. The hydrosphere covers about 70 percent of Earth's surface, most of which is in the oceans.¹ Only a small percentage of the water on Earth is freshwater, found in lakes, streams, and groundwater.¹ The water available on Earth makes the planet unique, as it is necessary for supporting life. The hydrological cycle, also called the water cycle, is a constant process of water circulation through the different water reservoirs, such as the clouds, groundwater, ocean, and surface water.¹ This cycle is an important part of all the Earth's sphere because water moves through the atmosphere, biosphere, and geosphere during the process. In addition, humans directly interact with the water cycle by pumping water from aquifers and surface water.

References:

1. About the Hydrosphere. (n.d.). *My NASA Data*. Retrieved from: <https://mynasadata.larc.nasa.gov/basic-page/about-hydrosphere>

Lessons:

1. Water Cycle
 - Background lecture
 - Water in your life activity—students will record all the ways they use water in their daily life
 - Water cycle modeling—students will create a model of the water cycle
2. Water Table
 - Water table demonstration—students will create a model of a water table in a glass jar
 - Class Discussion—students will participate in a class discussion about changes to the water table
 - Groundwater research—students will conduct background research on sources of groundwater in the Great Plains
 - Groundwater report—students will write a one to two page report on groundwater in the Great Plains

Lesson One: Water Cycle

Grade/ Grade Band: 9-12	Topic: Environmental Science/ Natural Resources	Lesson # 1 in a series of 2 lessons
Brief Lesson Description: In this lesson, students will explore the hydrosphere by reviewing the water cycle and how they use water daily.		
Performance Expectation(s): Students will be able to: <ol style="list-style-type: none"> 1. Construct a diagram of Earth’s hydrosphere and the movement of water through this system 2. Explain the importance of water to all life on earth 		
NGSS Standards: SC.HS.13 Earth's Systems SC.HS.13.3 Gather, analyze, and communicate evidence to defend the position that Earth's systems are interconnected and impact one another.		
Narrative / Background Information		
Prior Student Knowledge: Basic earth science background; This lesson provides background information on earth’s hydrosphere. Earth’s <u>hydrosphere</u> contains all the water on Earth’s surface, underground, held in ice, and in the atmosphere. The hydrosphere covers about 70 percent of Earth’s surface, most of which is in the oceans. Only a small percentage of the water on Earth is freshwater, found in lakes, streams, and <u>groundwater</u> . The water available on Earth makes the planet unique, as it is necessary for supporting life. The hydrological cycle, also called the <u>water cycle</u> , is a constant process of water circulation through the different water reservoirs, such as the clouds, groundwater, ocean, and surface water.		
Science & Engineering Practices: <ul style="list-style-type: none"> • Asking questions & defining problems • Developing & using models 	Disciplinary Core Ideas: SC.HS.13.3.D Plan and conduct an investigation of the properties of water and their effects on Earth materials, surface processes, and groundwater systems.	Crosscutting Concepts: <ul style="list-style-type: none"> • Systems & system models • Cause & effect • Stability & change
Possible Preconceptions/Misconceptions: Students may not know how water moves through the hydrosphere or how everything on earth relies on water. Students may have a very basic idea of the water cycle but may not understand how complex the process is.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <i>Lesson Materials and Preparations:</i> <ul style="list-style-type: none"> • Paper • Pencil • Computer with internet access • Poster board/ craft paper • Markers/colored pencils • Glue • Scissors <p>Prepare a brief background lecture covering the water cycle and the lesson vocabulary</p> <hr/> <p><u>Background Lecture</u>- Review the water cycle and provide students with lesson vocabulary. Explain that water is a vital resource to all living things.</p> <p><u>Water in Your Life activity</u>- Students will write down all the ways they use water in their daily life. After students have finished writing, break into groups of two or three. Students will share their water usage.</p>		
EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <u>Water Cycle Modeling</u> - Students will work together in groups of two or three to illustrate and label a model of the water cycle. The model should include all processes of the water cycle. After finishing, each group should present their model to the class.		
EXPLAIN: Concepts Explained and Vocabulary Defined: Review the water cycle. Answer student questions. Review lesson vocabulary. Vocabulary: <u>Hydrosphere</u> - all the water on earth’s surface, underground, in ice, and in the air		

Water cycle- process in which water moves through the atmosphere, surface water, and ground water

Evaporation- process in which water changes from a liquid to gaseous state

Precipitation- process in which water is released from clouds in the form of rain, snow, sleet, or hail

Condensation- process in which water changes from a gaseous to a liquid state

Transpiration- process in which water vapor is released from plant leaves into the atmosphere

Infiltration- process in which water moves into soil subsurface and rock layers

Percolation- process in which water flows through soil and porous rock

Runoff- process in which water flows over the earth's surface

Glacier- large frozen freshwater reservoirs

Groundwater- water held below earth's surface in soil, rock, or aquifer

ELABORATE: Applications and Extensions:

Hydrosphere Basics, Lesson Two: Water Table

EVALUATE:

Summative Assessment (Quiz / Project / Report): Water Cycle Model

At the end of the lesson, students will be able to:

1. Submit a water cycle model
2. Demonstrate knowledge of hydrologic processes

Additional Resources:

Water Cycle Vocab activity- <https://www.quia.com/jg/379327list.html>

Water Cycle Vocabulary- <https://www.vocabulary.com/lists/262038>

Water Cycle model- <https://www.noaa.gov/education/resource-collections/freshwater-education-resources/water-cycle>

Ogallala Aquifer- <https://www.climate.gov/news-features/featured-images/national-climate-assessment-great-plains'-ogallala-aquifer-drying-out>

Water Cycle- <https://climatekids.nasa.gov/water-cycle/>

Lesson Two: Water Table

Written by Mary Lou Alfieri, Adapted by Emily Reif

Grade/ Grade Band: 9-12	Topic: Environmental Science/ Natural Resources	Lesson # 2 in a series of 2 lessons
Brief Lesson Description: In this lesson, students will learn about fluctuations in the water table in response to environmental factors.		
Performance Expectation(s): Students will be able to: <ol style="list-style-type: none"> 1. Draw a conclusion based on evidence about how water table levels fluctuate in response to environmental factors 2. Identify how the water table influences the existence of surface water 		
NGSS Standards: SC.HS.13 Earth's Systems SC.HS.13.3 Gather, analyze, and communicate evidence to defend the position that Earth's systems are interconnected and impact one another.		
Narrative / Background Information		
Prior Student Knowledge: Basic earth science background; Water cycle background from lesson one Earth's hydrosphere contains all the water on Earth's surface, underground, held in ice, and in the atmosphere. The hydrosphere covers about 70 percent of Earth's surface, most of which is in the oceans. Only a small percentage of the water on Earth is freshwater, found in lakes, streams, and <u>groundwater</u> . The water available on Earth makes the planet unique, as it is necessary for supporting life. The hydrological cycle, also called the <u>water cycle</u> , is a constant process of water circulation through the different water reservoirs, such as the clouds, groundwater, ocean, and surface water.		
Science & Engineering Practices: <ul style="list-style-type: none"> • Asking questions & defining problems • Developing & using models 	Disciplinary Core Ideas: SC.HS.13.3.D Plan and conduct an investigation of the properties of water and their effects on Earth materials, surface processes, and groundwater systems.	Crosscutting Concepts: <ul style="list-style-type: none"> • Systems & system models • Cause & effect • Stability & change
Possible Preconceptions/Misconceptions: Students may not understand or know about the concept of the water table. Students may have a basic idea of how water levels are influenced. Students may think that surface water is only influenced by precipitation.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <i>Lesson Materials & Preparations:</i> <ul style="list-style-type: none"> • Wide mouth jars • Sand and gravel • Water • Food coloring • Cups • Markers • Markers • Computers with internet access • Paper • Pencil <p>Before the lesson, create water table demonstration jars for student groups. Each group should get a jar filled with sand and gravel, a cup of water, food coloring, and a marker</p> <ul style="list-style-type: none"> • Fill jars $\frac{3}{4}$ the way with sand and gravel mixture • Fill cups with water • Set out food coloring and markers • Write the instructions on white board for students to follow <hr/> Water Table Demonstration- Separate students into groups. Instruct each group to obtain their lesson materials (jar, water, food coloring, marker). Students should follow the instructions listed on the white board. Demonstration instructions: <ol style="list-style-type: none"> 1. Tilt the jar and slowly pour the water into the jar, allow the water to rise approximately halfway up the jar. 		

2. Mark the top of the water level on your jar. Draw a sketch of your setup and label the water level. What does this represent?
3. Add more water to the jar. Record what happens to the water level.
4. Add 10 drops of food coloring to the side of your jar. Observe and record what happens to the flow of food coloring.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:

Class Discussion- Lead a class discussion reflecting on the water table demonstration. Students should think critically about how environmental factors influence water table levels.

Use the following questions to guide discussion:

- How would you define the water table?
- What can you recall about water stored below ground?
- What happens to the level of the water table during a drought?
- How does the level of the water table impact above ground features, such as a river or lake?

Groundwater Research- Students will conduct research on the sources of groundwater Great Plains. Students will need to compile notes and references to prepare for a report.

Groundwater Report- Students will write a one to two-page essay on groundwater sources in the Great Plains.

The report should cover the following:

- Name of the groundwater source
- Map of the groundwater source
- Sources of input based on the water cycle
- Source of output based on the water cycle
- Human use of the source
- Environmental factors that influence water table level

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Explain environmental factors that influence changes in the water table level.

Review lesson vocabulary.

Vocabulary:

Water table- Underground surface which is permanently saturated with water

Aquifer- Underground layer of water-bearing permeable rock, sand, gravel, or silt

Water cycle- process in which water moves through the atmosphere, surface water, and ground water

Groundwater- water held below earth's surface in soil, rock, or aquifer

ELABORATE: Applications and Extensions:

- **Ogallala Aquifer, Lesson One:** Renewable or Non-Renewable?
- **Ogallala Aquifer, Lesson Two:** Ogallala Aquifer Recharge

EVALUATE:

Formative Monitoring (Questioning / Discussion): Class Discussion/ Groundwater Report

At the end of the lesson, students will be able to:

1. Identify and explain the factors that cause changes in the water table level
2. Conduct research on issues related to water resources and management

Additional Resources:

Water Table- <https://www.britannica.com/science/water-table>

Water Table Nat Geo- <https://www.nationalgeographic.org/encyclopedia/water-table/>

Water Table Demonstration- https://www.youtube.com/watch?v=b5NVu_UMk8k

Aquifers of the US- <https://water.usgs.gov/ogw/aquifer/map.html>

USGS Water Science School- https://www.usgs.gov/special-topic/water-science-school/science/aquifers-and-groundwater?qt-science_center_objects=0#qt-science_center_objects

Ogallala Aquifer

This section contains three lessons to explore renewable and non-renewable resources in the context of the Ogallala Aquifer. In these lessons, students will explore how natural resources are connected by investigating sources discharge and recharge for Ogallala Aquifer through a water table demonstration and research activity. Students will also participate in a water allocation roundtable to determine the best use of water from the Ogallala Aquifer. Lessons are geared towards grades 9-12.

The Ogallala is one of the largest aquifers in the world and is located in the Great Plains of the United States. This critical water source stretches through eight states and covers approximately 174,000 square miles of land.¹ The Ogallala acts as a main water source for much of the Great Plains and supports approximately one-fifth of all corn, wheat, corn, and cattle produced in the United States.¹ More than 90 percent of the water pumped out of the Ogallala is for agricultural irrigation.² The Ogallala Aquifer is not recharging at the same rate as it is being depleted at. In the past forty years, the Ogallala has dropped by approximately 325 billion gallons per year. Researchers speculate that the Ogallala Aquifer will take at least 6,000 years to refill if completely emptied.² While water is considered a renewable resource, it is important to consider the rate of renewable. The Ogallala Aquifer has been called “fossil water” because it formed over millions of years.² Understanding the factors that influence discharge and recharge is important for natural resource management.

References:

1. Ogallala Aquifer Initiative (n.d.) Landscape Initiatives. USDA Natural Resource Conservation Services. Retrieved from <https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/initiatives/?cid=stelprdb1048809>
2. Braxton Little, J. (2009). Saving the Ogallala Aquifer. *Scientific American*. *SA Special Editions*, 19:1S (32-39). Retrieved from <https://www.scientificamerican.com/article/the-ogallala-aquifer/>

Lessons:

1. Renewable or Non-Renewable?
 - Background lecture
 - Renewable or non-renewable game—students will identify if a resource is renewable, non-renewable, or perpetual.
2. Ogallala Aquifer Recharge
 - Water Table demonstration
 - Background research—students will conduct background research on the Ogallala Aquifer
 - Ogallala Aquifer model—students will create a model of the Ogallala Aquifer, identifying sources of discharge and recharge
3. Water Allocation Roundtable
 - Review lecture
 - Background research—students will use previous research and new research to prepare their argument
 - Roundtable activity—students will present their arguments in a water allocation roundtable discussion

Renewable or Non-Renewable?

Grade/ Grade Band: 9-12	Topic: Earth Science/ Natural Resources	Lesson # 1 in a series of 3 lessons
<p>Brief Lesson Description: In this lesson, Students will be exposed to the theory that everything is connected to everything else by identifying if a natural resource is renewable, non-renewable, or perpetual.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 1. Define renewable, non-renewable, and perpetual resources 2. Explain how natural resources are connected to one another 		
<p>NGSS Standards: SC.HS.13 Earth's Systems SC.HS.13.3 Gather, analyze, and communicate evidence to defend the position that Earth's systems are interconnected and impact one another.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic earth science background; natural resource vocabulary (renewable, non-renewable resources); water cycle background Earth is abundant with <u>natural resources</u>, such as water, which allow life to flourish. There are three basic types of natural resources, <u>renewable</u>, <u>non-renewable</u>, and <u>perpetual</u>. These categories allow for basic classification based on use and rate of regeneration. One of the most prevalent natural resources available on Earth is water, which goes through a continual cycle, called the <u>water cycle</u>. During this process, water can move from groundwater to surface water to the atmosphere and then back to surface water. Most of the water on the earth is held in the ocean, but other reservoirs, such as aquifers, are critical for life in the Great Plains. The Ogallala Aquifer is one of the largest aquifers in the world and is located in the Great Plains of the United States. This critical water source stretches through eight states and covers approximately 174,000 square miles of land. The Ogallala acts as a main water source for much of the great plains and supports approximately one-fifth of all corn, wheat, corn, and cattle produced in the United States.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Asking questions & defining problems • Developing & using models 	<p>Disciplinary Core Ideas: SC.HS.13.3.D Plan and conduct an investigation of the properties of water and their effects on Earth materials, surface processes, and groundwater systems.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Systems & system models • Cause & effect • Stability & change
<p>Possible Preconceptions/Misconceptions: Students may not understand or know how all resources are interconnected and dependent on one another. Students may not know about the different types of natural resources. Students may not understand or know about the concept of the water table. Students may have a basic idea of how water levels are influenced. Students may think that surface water is only influenced by precipitation. Students may not know much about the Ogallala Aquifer or how important it is the life in the Great Plains.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Defining Resources Part I</u>- Students will take out a piece of paper to write down their definition of renewable resource and non-renewable resource and provide an example of each. Students will draw a basic model of the water cycle. Provide approximately 10 minutes for students to complete this exercise.</p> <p><u>Background Lecture</u>- Review natural resource basics including renewable, non-renewable, and perpetual resources. Review the water cycle. Explain how natural resources are connected and interdependent. Ask students to share their definitions of renewable and non-renewable resources. Ask students to share their model of the water cycle.</p>		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> • Paper • Pencil • Background lecture • Water cycle model • Computers with internet access <p>Before the lesson, prepare a brief background lecture reviewing the basics of renewable, non-renewable resources, and the water cycle.</p>		
<p><u>Renewable or Non-Renewable? Activity</u>- Using the questions below, ask students to write whether the resource described is renewable, non-renewable, or perpetual. Note that some resources can be defined as both renewable and perpetual and renewable and non-</p>		

renewable depending on the rate of renewable. Ask students to consider the rate of renewable when completing this activity.

Renewable or Non-Renewable?:

- Water (renewable/perpetual)
- Air (renewable)
- Coal (non-renewable)
- Gold (non-renewable)
- Wind energy (perpetual)
- Forests (renewable/non-renewable—depends on the rate of renewable and how fast resources are being used)
- Soil (renewable)

Defining Resources Part II- After completing the activity, students will revisit their definitions from part I. Students will write their definition of a renewable and non-renewable resource and provide an example of each. Students will add on to or update their water cycle model.

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Explain how natural resources are interconnected.

Explain that some resources can be both renewable and non-renewable

Review lesson vocabulary.

Vocabulary:

Water Cycle- process in which water moves through the atmosphere, surface water, and ground water

Renewable Resource- natural resource that can be used continually because it is naturally replenished at a faster rate than consumption

Non-Renewable Resource- natural resource that cannot be used continually because it is not replenished at a faster rate than consumption

Perpetual Resource- natural resource that can be used continually because it is naturally replenished at the same rate as consumption

ELABORATE: Applications and Extensions:

- **Ogallala Aquifer, Lesson Two:** Ogallala Aquifer Recharge
- **Hydrosphere Basics, Lesson One:** Water Cycle
- **Hydrosphere Basics, Lesson Two:** Water Table

EVALUATE:

Formative Monitoring (Questioning / Discussion): Resource Definitions

At the end of the lesson, students will be able to:

1. Provide definitions of renewable, non-renewable, and perpetual resources
2. Explain how the use of natural resources is connected to everything on earth

Additional Resources:

Water Cycle Vocab activity- <https://www.quia.com/jg/379327list.html>

Ogallala Aquifer- <https://www.climate.gov/news-features/featured-images/national-climate-assessment-great-plains'-ogallala-aquifer-drying-out>

NatGeo Renewable Resources- <https://www.nationalgeographic.org/encyclopedia/renewable-resources/>

NASA Natural Resources- <https://www.nasa.gov/content/natural-resources>

Ogallala Aquifer Recharge

Grade/ Grade Band: 9-12	Topic: Earth Science/ Natural Resources	Lesson # 2 in a series of 3 lessons
<p>Brief Lesson Description: In this lesson, students will explore fluctuations in the level of the Ogallala Aquifer in response to discharge and recharge. Students will design a model of the Ogallala Aquifer demonstrating these changes.</p>		
<p>Performance Expectation(s): Students will be able to:</p> <ol style="list-style-type: none"> 3. Draw a conclusion based on evidence about how water table levels fluctuate in response to environmental factors 4. Identify how the water table influences the existence of surface water 		
<p>NGSS Standards: SC.HS.13 Earth's Systems SC.HS.13.3 Gather, analyze, and communicate evidence to defend the position that Earth's systems are interconnected and impact one another.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic earth science background; natural resource and water cycle background from lesson one The Ogallala is one of the largest aquifers in the world and is located in the Great Plains of the United States. This critical water source stretches through eight states and covered approximately 174,000 square miles of land. The Ogallala acts as a main water source for much of the great plains and supports approximately one-fifth of all corn, wheat, corn, and cattle produced in the United States.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Asking questions & defining problems • Developing & using models 	<p>Disciplinary Core Ideas: SC.HS.13.3.D Plan and conduct an investigation of the properties of water and their effects on Earth materials, surface processes, and groundwater systems.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Systems & system models • Cause & effect • Stability & change
<p>Possible Preconceptions/Misconceptions: Students may not understand or know about how all resources are interconnected and dependent on one another. Students may not know about the different types of natural resources. Students may not understand or know about the concept of the water table. Students may have a basic idea of how water levels are influenced. Students may think that surface water is only influenced by precipitation. Students may not know much about the Ogallala Aquifer or how important it is the life in the Great Plains.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Background Review-</u> Review lesson materials from lesson one. Ask students to define renewable, non-renewable, and perpetual resources. Review the water cycle.</p> <p><u>Water Table Demonstration-</u> Use the water table jar to demonstrate how precipitation and pumping influence the level of the water table. Demonstration instructions and discussion questions:</p> <ol style="list-style-type: none"> 5. Tilt the jar and slowly pour the water into the jar, allow the water to rise approximately halfway up the jar. 6. Mark the top of the water level on your jar. Draw a sketch of your setup and label the water level. What does this represent? 7. Add more water to the jar. Record what happens to the water level. 8. Add 10 drops of food coloring to the side of your jar. Observe and record what happens to the flow of food coloring. 9. Draw water out of the jar using a small syringe. What does this represent? <p>Ask students the following questions:</p> <ul style="list-style-type: none"> • How does this jar relate to the Ogallala Aquifer? • What factors influence the water level of the Ogallala Aquifer? 		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> • Wide mouth jar • Sand and gravel • Water • Food coloring • Cups • Syringe • Markers • Markers • Computers with internet access • Paper 		

- Pencil

Before the lesson, create water table demonstration jar using the following instructions

- Fill jars $\frac{3}{4}$ the way with sand and gravel mixture
- Fill cups with water
- Have food coloring ready to add

Background Research- Student will conduct background research on the Ogallala Aquifer. Students should identify an issue related to the Ogallala Aquifer. Students should take notes and compile references. Students will be creating a model of the Ogallala Aquifer, so it is important that they look at maps and water cycle models.

Ogallala Aquifer Model- Students will create a model of the Ogallala Aquifer, this can be done as a drawing, digital schematic, water table jar, etc. Students should demonstrate fluctuations in water levels and identify the cause of the fluctuations. Students will write a one-page report to accompany their model.

The report should cover the following topics:

- Recharge
- Discharge
- Human-caused changes
- Environmental changes
- Two interesting facts about the Ogallala Aquifer
- Explain how changes in the water table influence external factors (human, wildlife, natural resources, etc.)

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Explain the theory that everything is connected to everything else.

Review lesson vocabulary.

Vocabulary:

Water table- Underground surface which is permanently saturated with water

Aquifer- Underground layer of water-bearing permeable rock, sand, gravel, or silt

ELABORATE: Applications and Extensions:

- **Ogallala Aquifer, Lesson Three:** Water Allocation Roundtable
- **Hydrosphere Basics, Lesson One:** Water Cycle
- **Hydrosphere Basics, Lesson Two:** Water Table

EVALUATE:

Summative Assessment (Quiz / Project / Report): Ogallala Aquifer Model/ Report

At the end of the lesson, students will be able to:

1. Identify and explain the factors that cause changes in the water table level
2. Explain how natural resources are interconnected, using the Ogallala Aquifer as an example

Additional Resources:

Water Table- <https://www.britannica.com/science/water-table>

Water Table Nat Geo- <https://www.nationalgeographic.org/encyclopedia/water-table/>

Water Table Demonstration- https://www.youtube.com/watch?v=b5NVu_UMk8k

Aquifers of the US- <https://water.usgs.gov/ogw/aquifer/map.html>

USGS Water Science School- https://www.usgs.gov/special-topic/water-science-school/science/aquifers-and-groundwater?qt-science_center_objects=0#qt-science_center_objects

The Ogallala Aquifer- <https://www.climate.gov/news-features/featured-images/national-climate-assessment-great-plains'-ogallala-aquifer-drying-out>

Water Allocation Roundtable

Grade/ Grade Band: 9-12	Topic: Earth Science/Natural Resources	Lesson # <u>3</u> in a series of <u>3</u> lessons
<p>Brief Lesson Description: In this lesson, students will participate in a mock water allocation debate to determine the best use of water from the Ogallala Aquifer. Students will create an argument based on evidence to support their stance.</p>		
<p>Performance Expectation(s): At the end of the lesson, students will be able to:</p> <ol style="list-style-type: none"> 1. Use evidence to communicate their argument 2. Propose a solution to a complex problem 3. Identify the main sources of input and output from the Ogallala Aquifer 		
<p>NGSS Standards: SC.HS.13 Earth's Systems SC.HS.13.3 Gather, analyze, and communicate evidence to defend the position that Earth's systems are interconnected and impact one another. SC.HS.13 Sustainability SC.HS.15.5 Gather, analyze, and communicate evidence to describe the interactions between society, environment, and economy.</p>		
Narrative / Background Information		
<p>Prior Student Knowledge: Basic earth science background; natural resource and water cycle background from lesson one and two The Ogallala is one of the largest aquifers in the world and is located in the Great Plains of the United States. This critical water source stretches through eight states and covered approximately 174,000 square miles of land. The Ogallala acts as a main water source for much of the region and supports approximately one-fifth of all corn, wheat, corn, and cattle produced in the United States.</p>		
<p>Science & Engineering Practices:</p> <ul style="list-style-type: none"> • Asking questions & defining problems • Engaging in Argument from Evidence 	<p>Disciplinary Core Ideas: SC.HS.13.3.D Plan and conduct an investigation of the properties of water and their effects on Earth materials, surface processes, and groundwater systems. SC.HS.15.5.E Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p>	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> • Cause and Effect • Systems and System Models • Stability and Change
<p>Possible Preconceptions/Misconceptions: Students may not understand or know about how all resources are interconnected and dependent on one another. Students may not know about the different types of natural resources. Students may not understand or know about the concept of the water table. Students may have a basic idea of how water levels are influenced. Students may think that surface water is only influenced by precipitation. Students may not know much about the Ogallala Aquifer or how important it is the life in the Great Plains.</p>		
LESSON PLAN – 5-E Model		
<p>ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: <u>Review lecture-</u> Briefly recap the basics of renewable, non-renewable, and perpetual resources. Review the inputs and outputs of the Ogallala Aquifer. Review the process of a roundtable discussion.</p> <p><u>Background Research-</u> Students will use background information collected from lesson two and research how water from the Ogallala Aquifer is used. Students should compile evidence to use for their argument during the Water Allocation Roundtable activity. Students should write out a preliminary water allocation plan for the Ogallala Aquifer to be used in the next activity.</p>		
<p>EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: <i>Lesson Materials & Preparations:</i></p> <ul style="list-style-type: none"> • Computers with internet access • Paper • Pencil • Water Allocation Student Worksheet 		

Before the lesson, prepare a brief review lecture of the materials from lessons one and two. Print out enough worksheets for each student. Water Allocation Roundtable Part I- Divide students into groups of three or four. Each student will present their preliminary water allocation plan to their group. Students will defend their choice by using evidence to support their claim. After all students have presented their plan, the group must collectively design a water allocation plan to be presented to the class. Students must compromise and come to an agreement on how the water should be used.

Water Allocation Roundtable Part II- Each student group will present their water allocation plan to the class. Other student groups can ask questions or challenge claims. The presenting group should provide evidence for their choice. After all groups have presented, the class must collectively design a water allocation plan. Students must compromise and come to an agreement on how the water should be used.

Class Discussion and Wrap Up- Lead a class discussion based on the following questions.

- What are some of the main sources of input and output for the Ogallala Aquifer?
- Is it realistic to implement a water allocation for the Ogallala Aquifer? Why or why not?
- Why is it important to conserve water?
- How can you can conserve water?
- What was the most difficult part of this assignment?
- What was the most interesting part of this assignment?

EXPLAIN: Concepts Explained and Vocabulary Defined:

Answer any student questions.

Explain the process of a roundtable discussion.

Review lesson vocabulary.

Vocabulary:

Aquifer- Underground layer of water-bearing permeable rock, sand, gravel, or silt

Water Cycle- process in which water moves through the atmosphere, surface water, and ground water

Renewable Resource- natural resource that can be used continually because it is naturally replenished at a faster rate than consumption

Non-Renewable Resource- natural resource that cannot be used continually because it is not replenished at a faster rate than consumption

Perpetual Resource- natural resource that can be used continually because it is naturally replenished at the same rate as consumption

Roundtable discussion- an academic debate, where each person is given equal right to participate in discussion and debate

ELABORATE: Applications and Extensions:

- **Hydrosphere Basics, Lesson One:** Water Cycle
- **Hydrosphere Basics, Lesson Two:** Water Table

EVALUATE:

Formative Monitoring (Questioning / Discussion): Water Allocation Roundtable

Students will be able to:

1. Identify sources of input and output for the Ogallala Aquifer
2. Use evidence to construct an argument for water allocation
3. Propose a solution to a complex problem

Additional Resources:

Aquifers of the US- <https://water.usgs.gov/ogw/aquifer/map.html>

USGS Water Science School- https://www.usgs.gov/special-topic/water-science-school/science/aquifers-and-groundwater?qt-science_center_objects=0#qt-science_center_objects

The Ogallala Aquifer- <https://www.climate.gov/news-features/featured-images/national-climate-assessment-great-plains'-ogallala-aquifer-drying-out>

NRCS Ogallala Aquifer Initiative-

<https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/initiatives/?cid=stelprdb1048809>

Saving the Ogallala Aquifer- <https://www.scientificamerican.com/article/the-ogallala-aquifer/>

Water Allocation Student Background Research Worksheet

1. What are sources of input for the Ogallala Aquifer?
2. What are sources of output for the Ogallala Aquifer?
3. What is the main use of water from the Ogallala Aquifer?
4. Why are some areas of the Ogallala Aquifer depleting faster than others?
5. What are the main concerns with depleting the Ogallala Aquifer?
6. How many people rely on the Ogallala Aquifer for drinking water?

7. Write out your allocation plan. Include references to your sources.

8. References

Supplemental Information

For additional lessons and activities, please see the Educator's Resource Guide to Archaeology: Next Generation Science Standard-Based Lesson Plans for Grades 9-12. This guide includes over 10 lessons divided into four sections.

For additional information regarding artifact collection and curation, please see the Artifact Collection Curation for Citizen Scientists booklet. This guide includes collection laws, site documentation, artifact curation, benefits of curation, identification, and additional contacts.

For additional information on projectile identification, please see the Projectile Points of Northwestern Nebraska key and booklet. This guide includes typological identifications and full scale images of projectile points commonly found in Northwestern Nebraska.

To access full-resolution artifact scans, please see the Grasslands Artifact Roadshow 2D artifacts page on the Grasslands Artifact Roadshow website.

To contact a researcher for the Grasslands Artifact Roadshow, please email Dr. Matthew Douglass at mdouglass3@unl.edu.

To contact the Nebraska National Forests and Grasslands in Chadron, Nebraska, please call (308) 432-0300.

To Contact the National Grasslands Visitor Center in Wall, South Dakota, please call (605) 279-2125.