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	Suggested Procedure

Lesson 2: The Landscape Equation

Unit: 5th Grade Ecology Unit: A Sagebrush Expedition

Lesson: The Landscape Equation: (Landscape = Abiotic Components + Biotic Components + Cultural Components)

Overview: This lesson is an inquiry of breaking down the components of a landscape through the lens of an equation. Students will gain knowledge about the interdependent relationships between the abiotic, biotic and cultural components of a landscape in order to lead them to a deeper understanding of an ecosystem as a whole. Students will use observation skills to group and categorize objects in order to lead them to deciphering the landscape equation. Through hands-on activities and group work students will have the opportunity to understand the components of a landscape, learn new scientific vocabulary, create a model that demonstrates the interconnected relationships and describes the movement between these components, and begin to think about how humans play a role. These skills and hands on learning activities are significant in leading students to a deeper understanding of their local landscape; the sagebrush ecosystem

Main Take Away: Students will be able to grasp the different components present in an ecosystem, specifically the sagebrush ecosystem, through using the landscape equation as a model.

Learner Outcomes

Students will be able to...

- Make connections using the interdependent relationships between the three parts of the landscape equation help us understand the sagebrush ecosystem as a whole.
- Understand how humans are a part of the sagebrush ecosystem and can have both positive and negative effects on its landscape.
- Give examples of the components of the landscape equation (Landscape = Abiotic components + Biotic components + Cultural components), specifically for the sagebrush landscape.

Getting Ready

Materials: Abiotic objects or pictures, Biotic objects or pictures, Cultural objects or pictures, $L = A + B + C$ sign, large piece of paper, “The Sagebrush Sea” documentary, naturalist journals and pencil.

Preparation: Gather pictures and objects of abiotic, biotic, and cultural components. These should include objects that are found in the sagebrush ecosystem and objects that are not. Review the lesson to make sure activities are understood. Make sure to have access to “The Sagebrush Sea” documentary and means to play it.

Location: In the classroom or some activities can be done outside in an open space.

Length of Time:

1-2 Lessons

Approximately 60-75 minutes each

NGSS Standard(s) Addressed:

- **Disciplinary Core Ideas:**
 - LS2. A: *Interdependent Relationships* in Ecosystems
 - ESS3.C: Human impacts on Earth systems
- **Cross Cutting Concepts:**
 - Systems and System Models: A system can be described in terms of *its components and their interactions*.
- **Science and Engineering Practices:**
 - Developing and *Using Models* to describe

Place-Based Principle(s) Addressed:

- Engaging students in investigation, inquiry, and problem solving

<p>phenomena.</p> <ul style="list-style-type: none"> ○ Engaging in argument from evidence <p>• Connections to Nature of Science: 5-LS2-1:</p> <ul style="list-style-type: none"> ○ Science, Models, Laws, Mechanisms, and Theories explain Natural Phenomena. Science explanations describe the mechanisms for natural events 	
<p>Unit Connections (How specific lesson connects to overall goals and objectives of the unit)</p>	
<p>Transfer Goals: <i>Students will be able to independently use their learning to understand that...</i></p> <ul style="list-style-type: none"> • TG1- Science is a process that helps us gain a collective understanding of how the world works, it is a lifelong process, it is applicable every day, and accessible to everyone. • TG2- Humans are an interconnected part of the natural world and can have both positive and negative impacts. • TG3- Cultivating a sense of place, through intentional interactions, inspires curiosity about one’s community and helps to develop a conservation ethic. 	
<p>Unit Essential Question: <i>Students will keep considering...</i></p> <ul style="list-style-type: none"> • What is special about my community and what can I learn from it? • How can my actions, as a human, impact my community? 	
<p>Specific Lesson Content Objectives: <i>students will be able to...</i></p> <ul style="list-style-type: none"> • Make connections using the interdependent relationships between the three parts of the landscape equation help us understand the sagebrush ecosystem as a whole. • Understand how humans are a part of the sagebrush ecosystem and we can have both positive and negative effects on its landscape. • Give examples of the components of the landscape equation (Landscape = Abiotic components + Biotic components + Cultural components), specifically for the sagebrush landscape. 	
<p>Specific Lesson Language Objectives: <i>Students will be able to...</i></p> <ul style="list-style-type: none"> • Understand the meaning of abiotic, biotic, culture, and landscape. 	<p>Key Vocabulary Words:</p> <ul style="list-style-type: none"> • Landscape • Ecosystem • Abiotic • Biotic • Culture • Interdependent
<p>Background Information for the teacher: Students will gain knowledge about the interdependent relationships between the abiotic, biotic and cultural components of a landscape in order to lead them to a deeper understanding of an ecosystem as a whole.</p> <p>Abiotic components of a landscape are non-living chemical and physical parts of the environment that affect living organisms and the function of the ecosystem. Some examples are water, soil, light, radiation, temperature, humidity, atmosphere, clouds, snow and periodic disturbances.</p> <p>Abiotic factors:</p>	

- a. Sunlight: The amount of available sunlight varies from place to place on Earth and within individual ecosystems. Producers, organisms that can produce their own food, rely on sunlight to photosynthesize.
- b. Geology: The study of geology varies widely from place to place. For example, soil can be coarse sand on beaches and deserts or fine clay in riverbanks and marshes. The shape of the land, or topography, also helps to determine the makeup and water availability of any ecosystem.
- c. Water: Availability of water directly affects the organisms of an ecosystem. The biological diversity of an area is dependent on the presence of water. Organisms depend on different amounts of water to survive and must adapt to what is available.
- d. Temperature: Varies widely between ecosystems and changes seasonally within an ecosystem. The majority of organisms are unable to maintain an internal temperature more than a few degrees above or below the surrounding temperature. This limits where different species can be found.
- e. Wind: The driving force behind weather patterns; it shapes ecosystems daily through seed dispersal, shifting substrate, and storm damage. It also aids evaporation and is a constant threat of desiccation to terrestrial organisms.
- f. Periodic disturbances: Most ecosystems undergo periodic disturbances that interrupt the “normal” functioning of the ecosystem. As an example, forests can have disturbances like floods, fires, or short-term drought. These disturbances happen frequently enough that species have developed adaptations, which help them survive or take advantage of the disruption. In many cases, organisms rely on disturbances for their survival, such as Lodge pole pines, whose serotinous cones rely on the heat of the fire to open. (Schutsky, Kaufman, & Signell, 2006)

Biotic components of a landscape include everything that is living, was once living, or derived from something that is living. Examples are mammals, birds, reptiles, plants, decomposers, insects, scat, wood, etc.

Biotic factors:

Organisms, adapted to living within certain ecosystems, engage in competition for resources like water, sunlight, space, food and nutrients. They often engage in actions that are mutually beneficial to each species. The most important ecological distinction between organisms is how they get their nutrients. Organisms get their nutrients in three basic ways: the producers through photosynthesis, consumers through ingestions, and decomposers through absorption. (Schutsky, Kaufman, & Signell, 2006)

Cultural components of a landscape include anything that was human made or in any way that humans influenced the landscape. Examples are telephone poles or wires, fences, roads, hiking or hunting trails, dams, petroglyphs, etc. These components may have once been a biotic factor such as a wooden fence post but have been changed and manipulated to meet the needs of humans. Humans have been changing and manipulating the landscape since we arrived in North America through hunting, gathering, agriculture, and construction. In more recent years we have had an even bigger impact on the landscapes that surround us through our infrastructures. They are included and important in the landscape equation because humans have such a large influence on ecosystems. It is important to recognize and understand these components and the impacts they play because, as humans, we are also an intricate part of the landscape and the interdependent relationships that exist within that ecosystem.

Examples specific to Sagebrush:

Abiotic: Soil, rocks, clouds, water in the soil, temperature, etc.

Biotic: Sage grouse, pronghorn, beetles, ants, western meadowlark, sagebrush lizard, grey fox, Indian paintbrush, Bitter brush, Rabbit brush, Mountain Big Sage, mushrooms, etc.

Culture: fences from ranches, telephone poles, oil pads, roads, trails, crops, ancient ruins, petroglyphs etc.

Building Background for Students: (ELL principle)

Activate Prior Experiences:

The teacher will explain that students will do the following:

1. Closely examine what makes up the sagebrush ecosystem.
2. Explain that before today's activity there will be a brainstorming activity of things that might be found in the sagebrush ecosystem by creating a concept map chart on a large piece of paper.
3. Prior to the brainstorming activity ask, "Can anyone share a story of a time you spend in this community?"
4. Have 2-3 students share an experience they had in the sagebrush community.
5. Give each student a few post-it notes and ask them to write or draw a picture of things they believe they could find in the sagebrush ecosystem.
6. Students will place their post it notes on the poster that says "sagebrush ecosystem."
7. Students share what they wrote or draw to help all students gain a better understanding of what can be found in this community.

Link to New Learning from Prior Learning:

The teacher will explain to students that they will:

1. Engage in an activity that will help categorize things that can be found in the sagebrush ecosystem.
2. Work in pairs to explore various pictures and objects that are placed around the room. Their job is to make observations and think of ways in which they could group these pictures and objects. This activity will lead students towards categorizing their findings into the landscape equation that is composed of abiotic, biotic, and cultural factors.
3. Compare the pictures and objects in the room to what they have put on the sagebrush ecosystem chart.
4. Add any new ideas to the chart, thinking about whether this object is living, non-living, or human related.

Vocabulary:

The teacher will:

1. Explain that words will be added throughout the unit and that students should consult the wall. For this lesson the words abiotic, biotic, culture, and landscape will be added.
2. Pictures and objects placed around the room will include its name written out for students who may not recognize the object. These words should be written in the native language to assist ELL students.

Common Student Misconceptions/Student Challenges:

- Not everything in an ecosystem is connected to one another
- Humans are not part of the landscape model

Materials:

- Abiotic objects or pictures
- Biotic objects or pictures
- Cultural objects or pictures
- L = A + B + C sign
- Large piece of paper for list
- "The Sagebrush Sea" documentary

Set-up:

- Collect objects that represent abiotic, biotic and cultural components of the equation.
- Set these up around the room or outside space
- Have a place to write the initial list (poster paper or white board)
- Have L=A+B+C written on a large piece of paper that is ready at hand after students come up with the equation.
- Have access to the "Sagebrush Sea" documentary.

Lesson Agenda	Suggested Procedure (step-by-step)	ELL Rationale
<p>Review: Approximately 10min</p> <p>Engage: Approximately 30min</p>	<ul style="list-style-type: none"> • Have students think of at least two things they remember about how maps can help us better understand our local community. • Pose the following questions: <ul style="list-style-type: none"> ○ "What can maps teach us? How can we use maps to help us better understand our local community?" ○ Have students share their ideas with the person sitting next to 	<ul style="list-style-type: none"> • Naming two things they remember helps students recall information. This helps increase

<p>Brainstorm about Sagebrush Ecosystem</p> <p>Watch a clip from “Sagebrush Sea”</p>	<p>them.</p> <ul style="list-style-type: none"> ○ Ask a few students to share what they discussed with the entire class. <ul style="list-style-type: none"> • Remind students that: “yesterday we took a look at our personal community and then looked at the community of Wyoming through different maps on WyoBio. Today we are going to think about our natural community.” <ul style="list-style-type: none"> ○ Pose the following question: <ul style="list-style-type: none"> ▪ “What ecosystem is most dominant here in our community?” (<i>Sagebrush Ecosystem</i>). • Have students work in a small group to create a list of what we might observe and find in the sagebrush ecosystem. <ul style="list-style-type: none"> ○ Have students write this brainstorm list in their naturalist journals. • Probes if students are struggling: <ul style="list-style-type: none"> ○ “What birds, insects, plants, or signs of humans might we observe in the sagebrush? What kind of weather might we experience?” • Ask students to write down their brainstorm on a big piece of paper provided. (D1) <p>Sagebrush Sea:</p> <ul style="list-style-type: none"> • Explain to students that they will watch the introduction clip from “The Sagebrush Sea” • Explain that students will need to record what observations of what lives in the sagebrush ecosystem according to what they see in the film. Students will record their observations in their naturalist journals. • After movie clip, ask students to make additions to the original list. 	<p>thinking.</p> <ul style="list-style-type: none"> • Small group work will increase interaction. • Lower ELL students can list or draw what they might find in the sagebrush ecosystem. • Brainstorming helps to increase thinking and activate prior knowledge. • Watching a film will help increase comprehensibility. • Making additions to original brainstorm will help link prior knowledge to new learning.
<p>Explore: Approximately 30min</p> <p>Students will categorize pictures and objects based on observations</p>	<ul style="list-style-type: none"> • Have students work in pairs or small groups to explore various objects and pictures that are placed around the room. <ul style="list-style-type: none"> ○ Students will walk around and make observations about the objects and pictures. ○ Pose the following questions: “What are these things? What do they have in common?” ○ <i>Potential student responses: (will name the picture or object. The rabbit, mouse, and deer all have fur)</i> ○ Pause students and have them talk about what they are observing. 	<ul style="list-style-type: none"> • Small group and pair group increases interaction. • Classifying and categorizing and describing increases higher order thinking.

	<ul style="list-style-type: none"> ○ Ask student if they have any questions? <ul style="list-style-type: none"> ▪ Have peers help to answer these questions first. • Have students walk around the room again, and this time direct students to decide how they would group or categorize some of these pictures and objects. <ul style="list-style-type: none"> ○ Have them write these thoughts in their naturalist journal? (D2) • As an entire class, discuss their category and group choices. Have students physically place the objects and pictures into these various groups and discuss why they placed them into a particular group. • Pose following questions: <ul style="list-style-type: none"> ○ “Does anyone agree or disagree? Why or why not?” ○ Compare the groups. “What are some similarities and differences you notice between the groups? Could any objects be in multiple groups?” ○ <i>Potential student responses: (This group has animals with fur, which is similar to the group over there. However, this group contains objects that these animals would eat, such as plants.)</i> <ul style="list-style-type: none"> ▪ Emphasize some of the living and nonliving objects because this will help them later with the landscape equation. Also encourage them to point out objects that are connected to humans (fence, petroglyph, crops, etc.) 	<ul style="list-style-type: none"> • Students’ asking other students before asking a teacher helps to increase interaction. • Pictures and objects will include names in both English and native language to help with new vocabulary.
<p>Explain: (next day) Approximately 20-30min</p> <p>Student development of the landscape equation</p>	<ul style="list-style-type: none"> • Explain to students that they will be learning a model today that is in the form of an equation. <ul style="list-style-type: none"> ○ Emphasize that models are important because they help us to simplify complex ideas, such as understanding the interdependent relationships that exist in an ecosystem. Models can be both explanatory and predictive. In this case, the landscape equation model is an explanatory model that helps us to explain how all the components that are found within an ecosystem are connected. <ul style="list-style-type: none"> ▪ For example: The landscape model explains that a landscape is composed, or made up of, abiotic parts, biotic parts, and cultural or human influenced parts. When we put them all together and begin to think about how they are all connected, we can begin to gain a picture of how all the pieces of this landscape or ecosystem are connected to one another. • Write on the board or have equation written on a large piece of paper 	<ul style="list-style-type: none"> • Constructing a model based on observations that students made helps to increase higher order thinking. • Learning new and key vocabulary in context. These new words can be added to the word wall.

	<p>(L = A + B + C).</p> <ul style="list-style-type: none"> • Pose following questions: <ul style="list-style-type: none"> ○ “What do you think this equation means?” ○ “What parts of the equation do you recognize?” “What parts do you not recognize?” <ul style="list-style-type: none"> ▪ Have students guess what they think the letters stand for. • Go back to the groups they created earlier. Emphasize the nonliving and living groups. <ul style="list-style-type: none"> ○ Pose the following questions: <ul style="list-style-type: none"> ▪ “What connections do you see that could link these two groups together?” ▪ <i>Potential student responses: (Water and plants, sagebrush and sage grouse, air and plants, etc.)</i> ○ Explain that scientists use specific vocabulary to describe these living and nonliving components of a landscape (Abiotic and Biotic). ○ Ask student what they think the “C” could stand for in the equation. <ul style="list-style-type: none"> ▪ Have them share with an elbow buddy before sharing with the entire class? ▪ Guide students to think about the human related objects and pictures from earlier. ▪ Pose the following questions: <ul style="list-style-type: none"> • “How do you think humans are a part of the landscape?” • Lead them to C= culture in the landscape equation. ○ <i>It is important that students reach these conclusions without being told by instructor. You can guide them and give them the tools needed to discover the meaning on their own.</i> • Once students understand what each part of the equation means ask them, “Why do you think these three components or parts make up a landscape?” <ul style="list-style-type: none"> ○ <i>Potential Student Responses: (They are all related; plants need sunlight and water to grow, rabbits rely on these plants for food, and humans might hunt these rabbits to feed to their families.)</i> 	<ul style="list-style-type: none"> • Real pictures and objects help to increase comprehensibility.
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	<ul style="list-style-type: none"> ○ Have them take a couple minutes to write their answers in their naturalist journal? <p style="text-align: center;">Have a few students share their thoughts.</p>	
<p>Elaborate: Approximately 30-45min</p> <p>Revisit pictures and objects to sort them according to the landscape model</p> <p>Brainstorm and discuss connections between the three components of the model</p> <p>Think about how the landscape equation connects to the idea of place and community</p> <p>Reflection Activity</p> <p>Ticket out to see what students understood about the lesson</p>	<p>Revisit Pictures and Objects:</p> <ul style="list-style-type: none"> • Focus students’ attention on the pictures and objects around the classroom again. • Pose the following question: <ul style="list-style-type: none"> ○ “If we are thinking about the landscape equation, how could we group these objects into the three components of the equation?” ○ <i>Possible student responses: (We could put them into non-living, living, and human influenced groups)</i> <p>Find connections among the three groups:</p> <ul style="list-style-type: none"> • Have students pick two or three items from the pictures and objects around the room to create a model that demonstrates the relationships in the Landscape Equation. (F1) • Ask students, “What connections exist to link these items together?” • Have students write or draw the example in their naturalist journal. <ul style="list-style-type: none"> ○ They must be able to explain their reasoning for these connections between the items they chose (Ex. plants need water and air and humans need plants to eat); label each item abiotic, biotic, or culture. <p>Connecting Landscape Equation to Place:</p> <ul style="list-style-type: none"> • Pose the following questions: <ul style="list-style-type: none"> ○ “Which objects might we find in the sagebrush ecosystem?” <ul style="list-style-type: none"> ▪ Have students point out the pictures and objects that are around the room that they believe might exist in the sagebrush landscape. ○ “Does this match our original list?” “Which objects had we not included in the original list?” <ul style="list-style-type: none"> ▪ Have students add these objects to the original list of what exists in a sagebrush landscape. (F2) ○ “Why do you think we may have forgotten these objects?” <p>Reflection:</p> <ul style="list-style-type: none"> • Pose the following to the class: “In thinking about human impact on the sagebrush ecosystem, what are your thoughts on the following questions?” <ul style="list-style-type: none"> ○ Please pick one (or two) of the following questions available to reflect upon and record in your naturalist journal. 	<ul style="list-style-type: none"> • Real pictures and objects increase comprehensibility • Learning vocabulary in context through placing new words with actual pictures and objects. • Discussing connections among three groups increasing higher order thinking through comprehension. • Constructing a model encourages students to synthesize what they have learned about the landscape equation. • Connecting the landscape equation to place increases higher order thinking through the process of

	<ul style="list-style-type: none"> ▪ Inform students that they need to write 3-4 complete sentences for this reflection. ▪ “Do our cultural objects have positive and negative impacts on the sagebrush landscape?” “Or do they not have any impact at all?” ▪ Pick an object or picture in the room and record your thoughts on the impact it may have on the sagebrush ecosystem? ▪ Pick and object or picture in the room and record what impact it could have on our community? (S1) <i>Could be one of their graded reflections for the naturalist journal assignment.</i> <p>Ticket out:</p> <ul style="list-style-type: none"> • On a piece of scrap paper have students respond to the following questions: <ul style="list-style-type: none"> ○ What was the big idea of this lesson? ○ Give an example of one abiotic, biotic, and cultural component that can be found in your community. ○ What questions do you still have? (F3) <p><i>Landscape Quilt Activity: (If time remains or can be done on a field trip day)</i> (S2) A graded assignment based on completion.</p> <ul style="list-style-type: none"> ○ <i>On a field trip to the sagebrush or just outside the school have students draw the landscape they observe before them.</i> <ul style="list-style-type: none"> ▪ <i>Divide a piece of paper in their journal into four quadrants. In one quadrant they will draw any abiotic components they see, in the second quadrant they will draw any biotic components they see, in the third quadrant they will draw any human made cultural components, and in the fourth quadrant they will draw the whole landscape with all three components present.</i> ▪ <i>Have them share their landscape drawings with a peer to compare and contrast?</i> <p><i>Have students do a landscape quilt at school and one in the sagebrush and then have them compare and contrast their quilts. What are the differences? What are the similarities? What components are more prevalent in the quilt near their school?</i></p>	<p>application.</p> <ul style="list-style-type: none"> • Reflection increases interaction as students are given time to think independently or with a peer about what they have just learned. • Allowing lower level ELLs to draw instead of write allows them to share the content they have learned without the lack of language getting in the way. • The landscape quilt activity increases higher order thinking through application of the components of the landscape equation.
<p>Evaluations and Assessment Check ins: D: Diagnostic assessment F: Formative</p>	<p>(D1): Activity that will help instructor understand student’s prior knowledge of what can be found in the sagebrush ecosystem. (D2): A diagnostic of students’ conceptions of how organisms and human created artifacts are related and connected. (F1): A creative assignment that allows students to use what they have learned through the creation of a model that shows the parts of the landscape model</p>	<ul style="list-style-type: none"> • Assessments will increase interaction, comprehensibility, and higher order

<p>assessment S: Summative assessment</p>	<p>and how these parts are connected. (F2): Students will come back to original list to add additional layers based on what they have learned throughout the lesson. (F3): An informative assessment for instructor to see if students captured the main idea of the lesson, to show what they have learned, and to ask any questions they still do not understand. (S1): Assesses what students have learned about the impact that humans can have on a landscape and how we are ultimately connected to that landscape through the practice of reflection. (S2): A fun and creative way for students to put what they have learned into practice by applying the landscape equation to their own place and landscape.</p>	<p>thinking.</p> <ul style="list-style-type: none"> Journal assessments can be modified according to students' ELL level through creating a list, drawing or pointing to oral descriptions.
<p>References: Schutsky, Kaufman, & Signell, (2006).</p>		