Appendix A

Fifth Grade Science Unit: A Sagebrush Ecosystem Expedition

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A special thanks to Jamie Litvinoff for piloting the unit

Overview and Purpose Statement of Unit

Key for Bodies of Knowledge

Connections to science, ecology, and scientific practices and skills
Human Impacts on the Natural World
Connection to Place

Overview and Purpose Statement
Building science literacy through inquiry-based exploration and hands-on experiences empowers students to problem solve and think critically about current issues facing the scientific community. It gives them tools to successfully navigate and interact positively with their local ecosystem and community. Further, it allows them to observe the natural and social world, draw conclusions based on evidence, and make informed and productive decisions. *This unit will give students the opportunity to explore the diversity of life found within the sagebrush ecosystem.* *They will explore this landscape through scientific and historical land use lenses. Students will build capacity in scientific inquiry skills through observations and conducting field investigations of the multiple patterns and processes that make up this unique ecosystem by using the landscape equation as a model. They will be encouraged and challenged to participate and influence their peers as they practice analytical reasoning skills and make deep connections to the sagebrush ecosystem in which they live.* *During this unit, students will have the opportunity to build individual scientific literacy skills as they make observations, conduct small investigations that introduce the landscape and its parts, establish a connection to place, and practice the skills of a naturalist and scientist. They will become more familiar with the special qualities of the sagebrush ecosystem, while learning principles of ecosystem science. They will be challenged to make meaning of their observations, compare patterns in the landscape, synthesize their learning, and demonstrate understanding.* *The purpose of this unit is not only to teach students about the intricacy and complexity of the sagebrush ecosystem, but to have it meet the Next Generation Science Standards (NGSS), incorporate Place-Based Education (PBE) principles, and include strategies and best practices for English language learners (ELLs). To this end there are four main goals for this unit in an effort for students to better understand the Nature of Science this unit will focus on:* 1. *Understanding that scientific investigations use a variety of methods, scientific knowledge is based on empirical evidence, scientific knowledge assumes an order and consistency in natural systems, and science is a human endeavor.* 2. *Incorporate the seven principles of place-based education.* 3. *Establish a relationship between the Biodiversity Institute at the University of Wyoming and the Little Snake River Valley School that can be continued into the future.* 4. *Meet the learning levels of all students in diverse classrooms with a distinct focus on English language learners without sacrificing content.*

NGSS incorporated:

Disciplinary Core Ideas	Crosscutting Concepts	Science and Engineering Practices
LS1.C: Organization for matter and energy flow in organisms (Plants acquire their material for growth chiefly from air and water.)	Energy and Matter: matter is transported into, out of, and within systems	Engaging in argument from evidence
LS2.A: Interdependent relationships in ecosystems	Systems and System Models: a system can be described in terms of its components and their interactions.	Developing and using models
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Systems and System Models: a system can be described in terms of its components and their interactions.	Developing and using models
ESS3.C: Human Impacts on Earth Systems	Systems and System Models: a system can be described in terms of its components and their interactions.	Obtaining, evaluating, and communicating information

Nature of Science Concepts	Description
Scientific investigations use a variety of methods	• Scientific methods are determined by questions • Scientific investigation uses a variety of methods, tools, and techniques
Scientific knowledge is based on empirical evidence	• Scientific findings are based on recognizing patters • Scientists use tools and technologies to make accurate measurements and observations
Scientific knowledge assumes an order and consistency in natural systems	• Science assumes consistent patterns in natural systems. • Basic laws of nature are the same everywhere in the universe
Science is a human endeavor	• Men and women from all cultures and backgrounds choose careers as scientists and engineers. • Most scientists and engineers work in teams. • Science affects everyday life. • Creativity and imagination are important to science

Place-Based Education Principles Incorporated:

1. *Fostering love of one's place*
2. *Focusing on local issues and using local experts*
3. *Learning takes place in the school yard, community, and local environment*
4. *Learning is personally relevant to students*
5. *Engaging students in investigation, inquiry, and problem solving*
6. *Engaging students in experiential and project-based learning*

7. *Learning is interdisciplinary*

English Language Learner Principles Incorporated:

1. *Building Background: Activating prior knowledge, linking prior experiences to new learning experiences, introducing new and key vocabulary*
2. *Increase Comprehensibility*
3. *Increase Interaction*
4. *Increase Higher Order Thinking*

Stage One: Desired Results

<table>
<tr><th colspan="2">Stage 1 – Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Transfer Goals: Students will be able to independently use their learning to understand that…
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.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><td>Enduring Understandings: Students will understand that…
U1- The sagebrush ecosystem is made up of many moving parts that are all interconnected to one another.
U2- Human actions can have both positive and negative impacts on the sagebrush ecosystem.
U3- The use of naturalist and scientific practices and skills can lead to a deeper understanding of their local community.</td><td>Essential Questions: Students will keep considering…
Q1- What is special about my community and what can I learn from it?
Q2- How can my actions, as an informed citizen, impact my community?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><td>Knowledge: Students will…
K1 – Be able to identify and explain various reasons of what makes their community special.
K2- Know ways that humans can positively and negatively impact the sagebrush ecosystem.
K3 – Know how to use scientific investigation to explore the interdependent relationships and interactions in the sagebrush ecosystem.
K4- Be able to explain how matter cycles and energy flows through the sagebrush ecosystem.</td><td>Skills: Students will be skilled at…
S1 – Identifying and recognizing the three components of the landscape equation and giving examples of each component.
S2- Various scientific processes in order to explore, design, and implement scientific investigations, including engaging in argument from evidence, developing and using models to address systems and interdependent relationships, and obtaining, evaluating, and communicating information.
S3 – Using naturalist’s tools, such as field guides, dichotomous keys, binoculars, magnifying glasses, transect lines, soil cores, ribbon tests, and observation to identify notable flora and fauna in the sagebrush ecosystem.</td></tr>
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Stage Two: Assessment Evidence

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<tr><th colspan="2">Stage 2 - Assessment Evidence</th></tr>
<tr><td colspan="2">Prior Knowledge and Skill Assessment: Students conceptions and skill levels will be uncovered by…
❖ Pre and Post Surveys: Students will be given a pre-survey to assess their prior knowledge and attitudes towards the sagebrush ecosystem and science practices. They will be given a post-survey at the end of the unit to re-assess their knowledge and attitudes towards the sagebrush ecosystem and science practices.
❖ Concept Map: Students will create a large classroom concept map to assess their prior knowledge about the sagebrush ecosystem. This will be re-visited at the end of the unit to assess what students learned through adding a second layer of knowledge to their original concept map.
❖ Assessment Probes: Students will be given various assessment probes in order to elicit their ideas about various topics such as living and nonliving things, what they already know about the sagebrush ecosystem. These assessment probes will be designed to discover students' prior knowledge in order to guide learning and discovering more about each topic.
❖ Informal Assessments: For individual lessons, instructors will use a variety of informal methods to assess knowledge. These will include diagnostic assessments to reach students' prior knowledge and misconceptions. These formative assessments are intended to help the teacher and students evaluate what they have learned and what they are able to do with this knowledge.</td></tr>
<tr><td>Performance Tasks: Students will demonstrate that they really understand through…
PT1/1 – Naturalist/Reflection Journal: Students will create a naturalist journal which will exhibit student engagement, exploration and learning, with emphases on the naturalist and scientific knowledge and skills practiced throughout the unit. It will be constructed from experiences both inside and outside of formal classes. This will be the place for students to record naturalist skills, such as species accounts, field and course notes. Finally, students will record their reflections on leadership, place, and cultural aspects of the sagebrush ecosystem.
PT2 – "Each 1 Teach 1" on local flora & fauna: Students will be asked to prepare an 'Each-One-Teach-One' lesson on a local flora, fauna or abiotic topics in regards to the sagebrush ecosystem. An "Each 1 Teach 1" lesson involves students working in pairs or small groups to investigate further into a topic of their choice. They will then present their findings to the entire class. Each pair of group of students will present their lesson during an allotted amount of time and will be given feedback from their peers. Students will take notes during each other's lessons to hone in on a more in-depth understanding of their local ecosystem.</td><td>Other Evidence: Students will demonstrate that they achieved Stage 1 through…
OE1/1 – Mini SCI (Scientific Investigation): Students will explore a question through science investigation using the science circle and reflect whether this process provides deeper understanding of the topic.
OE2/2/2/2 – Unit Participation, Understanding and Reflection: Students will end the unit by reflecting on their overall participation during lessons and projects, their understanding of what they learned throughout the unit, and reflect on the overall experience of learning about place through a scientific lens. This will be demonstrated by adding a second layer to the sagebrush concept map with different color post-it notes. They will write about and illustrate their experiences with sagebrush, science, and place through a reflection piece in their naturalist journals.</td></tr>
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PT3/3/3 – Culminating Synthesis Research Project: Students will participate in a culminating final research project where they will be able to express what they have learned throughout the unit about content and processes. Students will work in small groups and have the opportunity to research a topic they are curious to explore further. These topics will be based on lessons that were covered throughout the unit. Students will participate in the scientific process using the science circle as a model. In doing so they will continue to think about what is special about their community and what they can learn from it. Students will have time to think of their question, make a hypothesis, decide how they will gather data, gather the data and creatively prepare how they will share this information with others. During their presentation they will share what they have learned as well as make connections to the three components of the landscape equation, including the impacts that humans have on the topic they choose to research.	

Stage Three: Learning Plan Overviews

Stage 3 - Learning Plan Overviews

Focus Learning Events: *Student success at transfer, meaning and acquisition depends upon…*

NGSS Goals:

1. Support an argument that plants get the materials they need for growth chiefly from air and water.
2. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
3. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Nature of Science Goals:

1. Through mini scientific investigations a variety of scientific methods, tools and skills can be learned.
2. Observations and data collection lead to scientific knowledge that is based on empirical evidence.
3. Scientific knowledge assumes an order and consistency in natural systems that can be demonstrated through exploration of the movement of matter in an ecosystem.
4. Science is a human endeavor.
5. Science addresses questions about the natural world and material world.

Lesson Plan Overviews:

LE1: Introduction to Place Through Maps and Sagebrush:

Lesson 1 aims to get students to start thinking about place, community, and science. By creating maps of their own community and exploring maps in WyoBio, students will be introduced to the scientific process or "Science Circle". Students will be given the opportunity to (a) use their observation skills to create their own map as well as explore other maps (b) learn how information from observations can help in creating maps and (c) how maps can help them have a better understanding of their community.

LE2: Landscape Equation (Landscape = Abiotic + Biotic + Culture):

Lesson 2 focuses on 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.

LE3: The Importance of Air and Water in the Sagebrush Landscape:

Lesson 3 explores some of the abiotic factors that influence the sagebrush landscape. Students will review what they learned from the landscape equation through a fun game of Simon Says. They will then think about why plants rely chiefly on air and water to create their own food in order to grow. The emphasis here will be on the idea that plant matter comes mostly from air and water not from soil. Through inquiry, students will design a mini research investigation that explores deeper into the relationship between these abiotic factors and plants, allowing students the opportunity to witness how matter can be transported into, out of and within a system.

LE4: The Dirt on Soil in the Sagebrush:

Lesson 4 aims to have students dig deeper into soil. Although plants rely chiefly on air and water to grow, which they learned about last lesson, soil is extremely important for plants as it provides stability, nutrients, and holds water. Students will be given the opportunity to learn about how a local research scientist uses soil to predict the future of the sagebrush ecosystem as they learn how to test and take samples of the soil. They will learn about the different particle sizes in the soil and how this affects water retention, different layers that can be found in soil, and test the pH. They will then be asked to apply this knowledge to continue the story of their local sagebrush landscape as they work to gain a better understanding of this ecosystem.

LE5: The Cycle of Matter within the Trophic Levels:
Lesson 5 facilitates that students understand the meaning of matter and how it moves into, out of and within the sagebrush ecosystem among plants, animals, insects, decomposers and the environment. They will be given the opportunity to create a model demonstrating understanding of the different trophic levels and how matter moves between these layers through exploration, acting, application, and synthesis work. They will investigate how all species are connected, as well as, explore the idea that the removal of one species can affect the whole system. Students will develop a deeper understanding of the interconnected relationships that exist within the sagebrush landscape.

LE6: Plant Identification and Dichotomous Keys:
Lesson 6 begins the comparison and contrast of different plant species that are present in the sagebrush ecosystem. Students will focus on shrubs found in this landscape. Students will understand how dichotomous keys work by an activity where they will sort and categorize plant samples based on their unique characteristics. Students will understand the importance of using specific adjectives when describing and sorting plants in order to identify them by species. They will learn more about shrub species that exist in the sagebrush ecosystem through the practice of identifying samples using a simple dichotomous key. Students will continually make connections between how plants fit into the landscape equation throughout the lesson.

LE7: Exploring Insects in the Sagebrush Landscape:
Lesson 7 explores insects and other arthropods that exist within the sagebrush ecosystem. Students will investigate what kinds of insects they can find around their school yard and identify them to order. They will learn how to make bug traps in order to catch a variety of insects. They will be able to compare the insects found in their school yard to insects they find on a field trip to the sagebrush. Students will learn more about a particular order of insects by creating a species account of an insect they found. This account will include the insects' importance to the sagebrush ecosystem, what parts of the sagebrush ecosystem does it rely on, and what connections does it have with humans.

LE8: Sage Grouse: An Umbrella Species:
Lesson 8 integrates role playing as conservation biologists. Students will discover the meaning of an umbrella species and how the protection of an umbrella species can indirectly protect many other species who also rely and use the same habitat. Students will work in small groups to make a decision on which species to protect using evidence to justify their choice. Students will then have the opportunity to learn more about how the Greater Sage Grouse is considered an umbrella species in the sagebrush ecosystem through the research of UW student Jason Carlisle.

LE9: Humans in the Sagebrush Landscape:
Lesson 9 examines the various impacts that humans have on the sagebrush ecosystem. Through observations and explorations student will gain a better understanding of both the positive and negative impacts that humans can have on a landscape and how humans are an interconnected part of the natural world. Students will explore the idea of stewardship and how this effects the awareness of local issues.

Field Trip to the Sagebrush Ecosystem:

The goal of taking a field trip into the sagebrush ecosystem is to observe and apply the scientific concepts and skills that have been learned throughout the unit. Students will be given the opportunity to practice steps of the science circle through making observations as they explore the landscape, asking questions about their observations, and practice making hypotheses using evidence to justify their statements. Students will have the opportunity to demonstrate the learned scientific skills. Students will apply concepts such as the landscape equation through the creation of a landscape quilt. In addition, the field trip offers students the opportunity to learn new skills such as plant and bird identification as they travel in the land of the sagebrush.

Unit Progression

Unit Progression: *For deeper understanding, students will experience the following sequence*

	Themes of Each Week	Daytime Learning Events
Lesson Plans 1-2	Introduction to Place, the Scientific Process, Ecology, and the Sagebrush Ecosystem	Day 1: Introduction to Place through Maps and Sagebrush (Pre Survey)
	Landscape Equation (L = Abiotic + Biotic + Culture)	Day 2: The Landscape Equation
Lesson Plans 3-5 **Field Trip #1**	Abiotic: Plants rely on Air and Water for nutrients	Day 3: The Importance of Air and Water in the Sage (Abiotic)
	Abiotic: Soil composition and importance for plants in the sagebrush	Day 4: The Dirt on Soil in the Sagebrush (Abiotic)
	Abiotic and Biotic: Trophic Levels: Movement of matter and energy among flora and fauna in the sagebrush ecosystem	Day 5: Trophic Levels (Abiotic and Biotic)
	Mini SCI	Day 6: Field Trip #1 to Sagebrush Ecosystem
	Reflective Practice: Naturalist Journal	*(Include at least 1 Mini SCI in lessons above and at least 1 reflection in Naturalist Journal)*
Lesson Plans 6-7 **Each 1 Teach 1**	**Expert Groups: Each 1 Teach 1 Activity: Students having the opportunity to become the educators**	Day 7: Introduction to Each 1 Teach 1 Activity and work time
	Biotic: Plant Identification	Day 8: Plant Identification
	Biotic: Exploring Insects in the Sagebrush	Day 9: Exploring Insects of the Sagebrush Landscape
	Mini SCI	Day 10: Each 1 Teach 1 Presentations
	Reflective Practice: Naturalist Journal	*(Include at least 1 Mini SCI in lessons above and at least 1 reflection in Naturalist Journal)*
Lesson Plans 8-9 **Field Trip #2**	Biotic and Culture: Sage grouse acting as an Umbrella Species	Day 11: Sage Grouse: An Umbrella Species (Introduce Final Synthesis Project)
	Culture: Human Impacts on the Sagebrush Landscape	Day 12: Humans in the Sagebrush Landscape
	Synthesis: Human Culture and the Sagebrush Ecosystem Project Introduce and give time to work on final synthesis project incorporating all parts of the landscape equation	Day 13: Work day for final project
	Students will collect data and observations for group research projects	Day 14: Field trip #2 to Sagebrush Ecosystem

	Mini SCI *Reflective Practice: Naturalist Journal*	*(Include at least 1 Mini SCI in lessons above and at least 1 reflection in Naturalist Journal)*
Final Project	Synthesis: Human Culture and the Sagebrush Ecosystem Project	Day 15: Continue to work on final Project
		Day 16: Continue to work on final Project and presentations
		Day 17: Continue to work on final Project and presentations
	Final Presentations and Celebration of Learning	***Day 18: Final Presentations of Synthesis Research Projects (Post surveys)***

Lesson Plan Format

Each lesson plan in the *A Sagebrush Expedition* unit follows a carefully prepared format. The purpose of this format is to provide consistency throughout the unit that can be easily understood for instruction. Each lesson plan includes the following: (a) title, (b) overview of the lesson and the main take away, (c) learner outcomes, (d) getting ready; which includes materials, preparation, and location of lesson, (e) NGSS standards addressed, (f) how many lessons and length of time suggested, (g) unit connections, (h) specific lesson language objective, (i) building background section which includes how to activate students' prior experiences, how to link new learning from prior learning, and vocabulary, (j) key vocabulary words, (k) background information for the teacher , (l) common student misconceptions and student challenges, (m) suggested procedures, (n) assessment check ins, recognized by a symbol similar to this **(D1),** and (o) references. Each lesson plan includes NGSS connections, PBE principles that are highlighted in purple, and highlighted ELL modifications. The first four lesson plans highlight the ELL modifications as well as rationale for how each strategy or practice meet one of the four ELL principles: building background, increase comprehensibility, increase interaction, or increase higher order thinking. The remaining five lesson plans include a colored highlighting system of the ELL strategies and practices in relationship to which principle they are targeting. Figure 6 below represents the key used for the highlighting incorporated into the lesson plans.

Table 6

Essential Questions within each lesson plan.

Lesson Plans (LP)	LP 1	LP 2	LP 3	LP 4	LP 5	LP 6	LP 7	LP 8	LP 9
Essential Questions									
What is special about my community and what can I learn from it?	X	X	X	X	X	X	X	X	X
How can my actions, as an informed citizen, impact my community?	X	X						X	X

Note: Essential questions within each lesson plan. Table shows which essential questions each lesson plan aims to address

Table 7

Three Dimensions of NGSS within each lesson plan

Lesson Plans (LP)	LP 1	LP 2	LP 3	LP 4	LP 5	LP 6	LP 7	LP 8	LP 9
Disciplinary Core Ideas									
LS1.C: Organization for matter and energy flow in organisms (Plants acquire their material for growth chiefly from air and water)			X	X					
LS2.A: Interdependent relationships in ecosystems		X			X		X	X	
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems					X	X			
ESS3.C: Human Impacts on Earth Systems	X	X						X	X
Crosscutting Concepts									
Energy and Matter: matter is transported into, out of, and within systems			X	X	X	X			
Systems and System Models: a system can be described in terms of its components and their interactions		X			X	X	X	X	X
Scientific and Engineering Practices									
Engaging in argument from evidence		X		X	X			X	X
Developing and using models	X	X		X	X	X		X	
Obtaining, evaluating, and communicating information			X			X	X		X

Note: Where the three dimensions of NGSS are incorporated within the lesson plans. Chosen using NGSS Lead States (2013). Visual representation of where these dimensions are present within the unit.
Lesson Plans developed for the unit, *A Sagebrush Expedition* are included below.