RED BUTTE GARDEN BOTANY BINS

PATTERNS & PARTNERSHIPS: UTAH MOUNTAIN ECOLOGY

Lesson 1: Mountain Organisms – Patterns & Traits

Core Alignment: 5th Grade – Standard 5 – Objective 1
a. Make a chart and collect data identifying various traits among a given population.
Intended Learning Outcomes:
• Observe simple objects, patterns, and events and report their observations. • Compare things, processes, and events. • Describe or explain observations carefully and report with pictures, sentences, and models. • Use classification systems • Cite examples of how science affects life. • Science is a way of knowing that is used by many people not just scientists.
Vocabulary:
organism, trait, pattern Optional: taxonomy, taxonomic division (domain – species)
Time Commitment: These lessons are designed to provide a great deal of flexibility in both length and depth. Plain text in black contains the middle-of-the-road option, while text in red contains time-saving options and text in purple contains options to dive deeper into the subject matter.
30-50 minutes, 15-30 minutes, and 60+ minutes.

Lesson Summary

Students search for patterns within a selection of organisms found within the Northern Utah Mountain Ecosystems. Through grouping the organisms and subsequent discussion, they discover the concept of traits. The scientific field of taxonomy, which builds on an understanding of those trait, can be explored as well as the difference between living (biotic) and non-living (abiotic).

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Lesson 2: The Canine Conundrum – Types of Traits

Core Alignment: 5th Grade – Standard 5 – Objective 1
d. Contrast inherited traits with traits and behaviors that are not inherited but may be learned or induced by environmental factors.
Intended Learning Outcomes:
• Observe simple objects, patterns, and events and report their observations. • Compare things, processes, and events. • Describe or explain observations carefully and report with pictures, sentences, and models. • Use classification systems. • Cite examples of how science affects life. • Science is a way of knowing that is used by many people, not just scientists.
Vocabulary:
organism, traits, parent organism, offspring, inherited, learned behavior, acquired, instincts, species Optional: taxonomy, selective breeding, hybridize
Time Commitment: These lessons are designed to provide flexibility in both length and depth. Plain text in black contains the middle-of-the-road option, while text in red contains time-saving options and text in purple contains options to dive deeper into the subject matter.
30-60 minutes, 20-35 minutes, and 60+ minutes.

Lesson Summary

With a basic knowledge of traits in hand, we focus in on an animal species that is famous for its varied (and highly manipulated) traits, the Canines. *Canis lupus** (wolves and dogs) offers a great opportunity to observe not only the variation of traits within a species, but also the different sources of those traits. Inherited traits and instincts, or acquired traits and learned behaviors, are on full display with the canines. Students continue working on their pattern finding powers as they delve deeper into the world of traits. Canines also offer a fun and intuitive way to discuss how even early humans were excellent at finding patterns and scientific thought. They utilized their knowledge of inherited traits to breed wild wolves into domesticated dogs. Modern humans continued that legacy and created the incredible variety of dogs we have today. Much of this lesson follows the same template as the previous lesson.

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Lesson 3: Patterns in Plants – Traits and Survival

Core Alignment: 5th Grade – Standard 5

1-d. Contrast inherited traits with traits and behaviors that are not inherited but may be learned or induced by environmental factors.
1-e. Investigate variations and similarities in plants grown from seeds of a parent plant.
2-a. Compare the traits of similar species for physical abilities, instinctual behaviors, and specialized body structures that increase the survival of one species in a specific environment over another species.
2-b. Identify that some environments give one species a survival advantage over another.
2-c. Describe how a particular physical attribute may provide an advantage for survival in one environment but not in another.
2-d. Research a specific plant or animal and report how specific physical attributes provide an advantage for survival in a specific environment.

Intended Learning Outcomes:

- Observe simple objects, patterns, and events and report their observations.
- Compare things, processes, and events.
- Describe or explain observations carefully and report with pictures, sentences, and models.
- Cite examples of how science affects life.
- Science is a way of knowing that is used by many people, not just scientists.

Vocabulary:

environment, population, specialized structure, species, survival, variation, organism, traits, parent organism, offspring, inherited, learned behavior, acquired, instincts
Optional: ecology, ecologist, ecosystem

Time Commitment:

These lessons are designed to provide flexibility in both length and depth. Plain text in black contains the middle-of-the-road option, while text in red contains time-saving options ,and text in purple contains options to dive deeper into the subject matter.

45-60 minutes, 30-45 minutes, and 60+ minutes.

Lesson Summary

Your students have mastered mountain organisms, conquered the canine conundrum, and are now fully familiar with the who and what of traits! Now it's time to discover the where and why with a more challenging organism (due only to its lack of familiarity), the kingdom of plants! As your students gain a better understanding of the characteristics of the Utah Mountain Ecosystem, they'll discover how an organism's traits fit into that ecosystem. Students will also explore how the structure of a trait is tied to its function. This lesson culminates in the students combining the knowledge they've learned in the first three lessons as they study the organisms found in this bin. Like professional ecologists, they will investigate how an organism's traits help or hinder its success in an ecosystem and take a peek at what could happen if that ecosystem changes. Much of this lesson follows the same template as the previous lesson.

Lesson 4: Reading Rings – Resources and Survival

<table>
<tr><th colspan="3">SEEd Alignment: 6.4.1 – suggestions for acclimating to phenomenon education in italics</th></tr>
<tr><td colspan="3">Analyze data to provide evidence for the effects of resource availability on organisms and populations in an ecosystem. Ask questions to predict how changes in resource availability affects organisms in those ecosystems.</td></tr>
<tr><th>Disciplinary Core Ideas</th><th>Crosscutting Concepts</th><th>Science and Engineering Practices</th></tr>
<tr><td>• LS2.C : Ecosystem dynamics, functioning, and resilience</td><td>• Cause and Effect
• Stability and Change</td><td>• Ask Questions
• Analyze Data
• Engage in Argument from Evidence</td></tr>
<tr><th colspan="3">Vocabulary: <u>vocabulary is underlined</u></th></tr>
<tr><td colspan="3">resource, ecosystem Optional: dendrochronology</td></tr>
<tr><th colspan="3">Time Commitment: These lessons are designed to provide flexibility in both length and depth. Plain text in black contains the middle-of-the-road option, while text in red contains time-saving options, and text in purple contains options to dive deeper into the subject matter.</th></tr>
<tr><td colspan="3">40-50 minutes, 25-30minutes, and 60+ minutes.</td></tr>
</table>

Lesson Summary

Welcome to the wonderful world of dendrochronology! Studying the rings and markings on the cross-section of a tree trunk can reveal the life story of that tree, and give great insight to what is happening in the ecosystem the tree inhabits. Through investigation of "tree cookies" (cross sections of the entire trunk of the tree), you and your students will observe firsthand the effects of resource availability on an organism. Your observations can then be compared to climate data that covers the years the trees were alive. This investigation mimics the real-world work of dendrochronologists! The potential effects of greater changes in resource availability are then predicted on both an organism and population level by asking "what-if" questions to the class. Your students become dendrochronologists as you exit your classroom and explore the stories of the trees that exist in the ecosystem surrounding your school! Using the same tool as professional scientists (an increment borer), you can take core samples of your neighborhood trees and discover what secrets they hold. This is a great opportunity to create an ongoing project for your classroom that adds new core samples each year to chronicle the changes to your trees over time.

Lesson 5: Ecosystem Interactions
Utah Mountains and Across the World

SEEd Alignment: 6.4.2 – *suggestions for acclimating to phenomenon education in italics*		
Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. Emphasize consistent interactions in different environments such as competition, predation, and mutualism.		
Disciplinary Core Ideas	**Crosscutting Concepts**	**Science and Engineering Practices**
• LS2.A: Interdependent relationships in ecosystems	• Patterns	• Construct an Explanation • Engage in Argument from Evidence
Vocabulary: vocabulary is underlined		
predator, prey, cooperation, competition, symbiosis, mutualism, parasitism, commensalism Forb: non-woody plant, includes wildflowers and grasses, not shrubs or trees.		
Time Commitment: These lessons are designed to provide flexibility in both length and depth. Plain text in black contains the middle-of-the-road option, while text in red contains time-saving options, and text in purple contains options to dive deeper into the subject matter.		
50 – 100 minutes (2 classes) , 35-45 minutes, and 100+ minutes (2-3 classes).		

Lesson Summary

Patterns abound in this next adventure into the Utah Mountain Ecosystem! Students will investigate the interactions and relationships that consistently occur within this (and every other) ecosystem. They will take on the persona of an organism and discover what and how that organism eats, and the types of relationships it has with the organisms around it. Then your class will seek out other student/organisms that feed and live in a similar manner as they do. Once the groups have been established, a discussion will lead to descriptions and naming of these groups based on the way they interact with other organisms. Finally, the vocabulary of predator & prey, and competition, mutualism, and parasitism will be assigned to the patterns of interactions the students have observed. Investigating and understanding the interactions, and the potential effects of those interactions, within an ecosystem is the goal of Ecologists. Your students can take on this mantel by using their newfound understanding of organism interactions found within the Utah Mountain Ecosystem, and investigating whether these interaction patterns appear in other ecosystems as well.

Lesson 6: Fueling the Web
Modeling Matter and Energy

SEEd Alignment: 6.4.3 – *suggestions for acclimating to phenomenon education in italics*		
Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. Emphasize food webs and the role of producers, consumers, and decomposers in various ecosystems.		
Disciplinary Core Ideas	**Crosscutting Concepts**	**Science and Engineering Practices**
• LS2.B : Cycles of matter and energy transfer in ecosystems	• Energy and Matter	• Develop a Model • Engage in Argument from Evidence
Vocabulary: vocabulary is underlined		
producer, consumer, decomposer, abiotic, biotic, primary consumer, secondary consumer, tertiary consumer.		
Time Commitment: These lessons are designed to provide flexibility in both length and depth. Plain text in black contains the middle-of-the-road option, while text in red contains time-saving options, and text in purple contains options to dive deeper into the subject matter.		
50 – 100 minutes (2 classes) , 35-45 minutes, and 100+ minutes (2-3 classes).		

Lesson Summary

The incredible complexity of any given ecosystem can be hard to conceptualize. There is a dizzying array of interactions, both biotic and abiotic. Even professional ecologists can lose sight of the intricacies of the forest, for a subset of the trees. Creating models of ecosystems, and the flow of energy and matter that drives them, is a wonderful way to give a hint of the complexity that exists. In this lesson you and your students will use the bins specimens to create that model, producing a tangible representation of the flow of energy and connections of the Utah Mountain Ecosystems. Students will create a web between each organism's predators and prey, and see the potential effects of abiotic components on that web. But, the flow of energy and matter isn't just a matter of connections, it's also a matter of quantity and conservation. As energy and matter flows from the sun to plants to primary consumers to secondary consumers, etc., the amount of energy does not stay constant. Your students will explore the reasons that there are fewer organisms as you travel from the bottom to the top of the trophic pyramid. Ecologists and land managers need to understand the balance that exists between those trophic levels to grasp the domino effect that can occur when one of those levels is altered.

Lesson 7: Beetles and Trees – Stability and Change

<table>
<tr><th colspan="3">SEEd Alignment: 6.4.4 – suggestions for acclimating to phenomenon education in italics</th></tr>
<tr><td colspan="3">Construct an argument supported by evidence that the stability of populations is affected by changes to an ecosystem. Emphasize how changes to living and nonliving components in an ecosystem affect populations in that ecosystem.</td></tr>
<tr><th>Disciplinary Core Ideas</th><th>Crosscutting Concepts</th><th>Science and Engineering Practices</th></tr>
<tr><td>• LS2.C : Ecosystem dynamics, functioning, and resilience</td><td>• Stability and Change</td><td>• Construct Explanations
• Engage in Argument from Evidence</td></tr>
<tr><th colspan="3">Vocabulary: <u>vocabulary is underlined</u></th></tr>
<tr><td colspan="3">population stability</td></tr>
<tr><th colspan="3">Time Commitment: These lessons are designed to provide flexibility in both length and depth. Plain text in black contains the middle-of-the-road option, while text in red contains time-saving options, and text in purple contains options to dive deeper into the subject matter.</th></tr>
<tr><td colspan="3">50 – 100 minutes (2 classes) , 35-45 minutes, and 100+ minutes (2-3 classes).</td></tr>
</table>

Lesson Summary

Beetles, and dead trees, and population instability, Oh My! As you've likely heard on the news, or perhaps seen with your own eyes, there has been a drastic change to the ecosystems of most of Utah's Mountains and forests across the Western U.S. and Canada. Millions of acres of evergreen forests across the West have faded from brilliant greens to alarming shades of orange and finally to dull, dead browns as trees have succumbed to the current bark beetle outbreak. This color gradient acts as a map of populations that have become destabilized. Bark beetles are a native and natural part of western forests and of many tree's life cycles, but over the last few decades their numbers have exploded. Abiotic factors destabilized the bark beetles' populations, and the swarms of bark beetles in turn destabilized and decimated the population of most evergreen populations in the West.

Your students begin their investigation of this phenomenon by getting a look at the problem from afar, through drone footage, and then zeroing in on individual trees and the insect found inside. They will then break into teams and move through three stations where they will analyze data centered on the three main components of this outbreak; the bark beetles, the trees, and the climate. As they rotate the stations, they are tasked with constructing an argument about what has happened in that ecosystem and how populations were affected. Arguments are presented and debated with the goal of students creating an argument that makes sense to the class as a whole. Students further explore real world scientific problems, namely missing and incorrect data, and how to work with those limitations. Lastly, student investigate patterns of ecosystem changes and potential effects on populations through other ecosystems.

Lesson 8: Fires and Forests – Evaluating Solutions

SEEd Alignment: 6.4.5 – *suggestions for acclimating to phenomenon education in italics*		
Evaluate competing design solutions for preserving ecosystem resources and biodiversity based on how well the solutions maintain stability within the ecosystem. Emphasize obtaining, evaluating, and communicating information from differing design solutions.		
Disciplinary Core Ideas	**Crosscutting Concepts**	**Science and Engineering Practices**
• LS2.C : Ecosystem dynamics, functioning, and resilience	• Stability and Change	• Obtaining, Evaluating, and Communicating Information • Engage in Argument from Evidence
Time Commitment: These lessons are designed to provide flexibility in both length and depth. Plain text in black contains the middle-of-the-road option, while text in red contains time-saving options and text in purple contains options to dive deeper into the subject matter.		
50 – 100 minutes (2 classes) , 45-55 minutes, and 100+ minutes (2-3 classes).		

Lesson Summary

This lesson provides a final capstone where your students can apply all they've learned about how ecosystems functions on solving a real-world problem. Students now understand that a stable ecosystem is a sign of a healthy, balanced ecosystem and that biodiversity and resource availability are integral to a stable ecosystem. One of the greatest, and longest-running experiments in forest ecosystem health and stability has occurred over the last 100+ years as humans have tried to understand how to live with fire in our forests. Students will investigate how forests lived with fire before the large-scale interventions of the last century, how those interventions changed the forest, and evaluate solutions for creating healthy, stable forests in the future. A large part of the story of fires in our forests has been the tale of Smokey Bear. Smokey was instrumental in spreading the message that fires are a force of deadly destruction and a foe to be battled and overcome at nearly any cost. Even as our understanding of fires natural place in the forest has changed, the public perception of Smokey and the fear of fires has largely remained. In this capacity, Smokey presents a great opportunity to discuss the power or propaganda in policy making, sometimes even eclipsing science in understanding and creating healthy forests.