RED BUTTE GARDEN BOTANY BINS

PATTERNS & PARTNERSHIPS: UTAH MOUNTAIN ECOLOGY

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.

Essential Questions

- What patterns exist in the ways that organisms feed themselves?
  - Can an organism be included in more than one category?
- What patterns exist in the relationships between organisms?
  - Can an organism be included in more than one category?
- Are the same patterns found in all ecosystems?

Enduring Understanding

- All organisms need food, and there are patterns in the ways that organisms feed themselves.
- All organisms interact with other organisms in their ecosystems, and there are patterns in the types of interactions that occur.
- Organism interactions may vary in specific details between different ecosystems, but remain consistent in their overarching patterns.

Previous Knowledge

Your students likely have a good deal of familiarity with many of the animals they will study in this lesson (though a few might be a surprise!) They also likely have the understanding that all organisms need food, and that there is a variety in the types of food an organism might eat and how that organism might get that food. Many in your class have also felt the comfort of cooperation, the pressure of competition, and the frustration of a parasitic relationship. The goal of this lesson is to help them understand that these interactions and relationships are universal throughout all organisms and ecosystems.

Background Information

The work of an ecologist is not dissimilar to that of a detective. Both have a solid understanding of the predictable patterns they might find, and have to figure out how those patterns might fit into the mystery they find before themselves. The ecologist understands that all organisms have to have food to fuel their life processes. Some organisms create that food within themselves; harnessing the power of the sun to split and join molecules to create the sugars that fuel their lives. Others rely on finding and consuming other organisms, and often then become food themselves. These patterns exist across all ecosystems, no matter how big or small, complex or simple. Predator is the name we give the organism that is currently eating, and prey is the name we give the organism being eaten. The designation of predator or prey for an organism can change within moments or last a lifetime, but both always exist within any given ecosystem. Ecologists can be, and often are, surprised with how the predator prey dynamic might manifest in an organism. For example, the discovery of parasitic and

carnivorous plants, and the further discovery of how common each of those are across many different ecosystems. Plants were once thought of as being solidly and exclusively in the category of prey, then as only very occasional predators, and now are known to be predators in a number of ways and far more regularly then ever considered before. Whether by stealing food directly from other plants, from fungi, from fungi-plant associations, through fall-traps, sticky-traps, snap-traps, bladder-traps, and more, plants can definitely be considered potential predators.

The ecologist further understands that patterns can be found in the way's organisms interact with one another, beyond the predator prey relationship. These relationships and interactions are again largely based on the needs of the organisms. Beyond food, organisms most commonly need water, shelter, and space. While all organisms have these basic needs, how they obtain and protect them can differ. When resources are scarce almost all organisms will begin to compete against one another, but when there are adequate resources organisms' strategies may move to more cooperative actions. Competition can be seen in wolf packs vying for territory to hunt elk, plants racing upward to prevent others from shading them out, or sheep ramming heads to win the ability to mate. Cooperation is found in many family groups living, feeding, and defending together such as bees, beavers, or coyotes or in the interactions between different types of organisms like bees and flowers. When organisms closely interact with different types of organisms the relationships are categorized in three main ways: mutualism (interactions where all organisms benefit), commensalism (interactions where one organism benefits, and the other is unharmed or unaffected), and parasitism (interactions where one organism benefits and one is harmed.) Mutualism is seen in the relationships between fruit bearing plants and birds, the bird benefits from the food of the fruit and the plant benefits by having its seeds spread. Commensalism occurs when animals like squirrels and porcupine live in trees, they benefit from the shelter and the tree is not harmed. Parasitism can be observed in the relationship between ticks and their hosts, the tick benefits from the blood of its prey and the host is harmed by losing blood and sometimes the introduction of disease. Ecologists understand that any one given organism interacts with many other organisms in many different ways. When trying to understand a phenomenon they encounter, ecologists are often pulling on one string in a great tapestry and the more they follow that thread the more they discover, but the general types of threads or relationships remain the same. For example, ecologists and botanists have relatively recently discovered that many forest plants are connected through massive networks of fungi that bind themselves to roots. For a long time, plants were not considered when discussing concepts like inter-species cooperation. We now understand that plants not only utilize this mycorrhizal network to grow to larger sizes than they could otherwise, but also to share food, water, minerals, and signals to other plants in their network. The fungi take a portion of the food for themselves and share the water and nutrients they absorb from the soil. Together, all the members of the network contribute to a forest that is healthier and stronger than it would ever be apart. This cooperative, mutualistic relationship between the plants and fungi can be found in forests around the world.

Predation and prey, cooperation and competition, mutualism, commensalism, and parasitism are the patterns that have been found to be universal amongst organisms. Regardless of the continent, country, ecosystem, or organism, the general patterns of interaction are repeated.

Predator	An organism that kills and consumes another organism
Prey	An organism that is killed and consumed by another organism
Cooperation	Groups of organisms working together for their mutual benefit
Competition	Organisms working against each, or attempting to defeat each other, in order to win access to a resource
Symbiosis	Two organisms that interact with each other, typically of different types and typically with a close relationship
Mutualism	An interaction between organisms where both benefit
Commensalism	An interaction between organisms where one benefits and one is unharmed
Parasitism	An interaction between organisms where one benefits and one is harmed

Lesson Plan:
Ecosystem Interactions –
Utah Mountains and Across the World

Materials	Location
Plant & Organism Rikers	Botany Bin
Fauna Photos	Botany Bin – Fauna Photo Folder
Blackline: L5 Ecosystem Interactions – Utah Mountains	Addendum Folder – Tab L5 or USB – L5 Folder
Pencils or Pens	Classroom supplies
White/Smart Board for group discussion	Classroom supplies
Optional:	
Blackline: L5 Ecosystem Interactions – Across the World	Addendum Folder – Tab L5 or USB – L5 Folder

Preparation

- There are 108 different specimens in the bin, so there are likely more specimens than students in your class. This is wonderful in that it allows your students to encounter a larger variety of organisms during their time with the bin, but also necessitates a little forethought when choosing specimens for the activities. We recommend taking 5–10 minutes to familiarize yourself with the organisms in the bin before you conduct any of the lessons.
- This lesson includes two options for conducting the activity. Read the lesson and choose the option that will work better for your class before choosing your organisms, as the different options require different organism selection.
- For the following two activities you will want to select a sampling of organisms that showcase both predators and prey (i.e. not only choosing predators, but making sure to get predators along with both plant and animal prey), and examples of different relationship types (see suggestions below). You can choose two sets of organisms and have your students repeat the activities with different organisms, this can help to reinforce the concept of repeating patterns of interactions.
- For a quicker lesson (as described further below) you will want to preselect a few examples showing a variety of traits.

Some suggestions for organism selection for this lesson…	
Predator & Prey	Remember that nearly every organism is both predator and prey at one point in their lives. The idea is to get a sampling of stereotypical predators like the felines & canines along with some of the predators that might get overlooked, like the oyster mushroom fungus, mice, flying squirrels, ladybugs, and spotted coralroot orchid. Also pick a diversity of prey animals, with examples of plants, insects, and different sizes of mammals.
Cooperation	Cooperation is most easily displayed in animals that live in herds, like wolves, deer, beaver, sparrows, bees, etc. But can also be found in the mycorrhizal connection between the tree cookie samples and the boletus fungus, humans bringing hay to livestock, lichens, etc.
Competition	Competition could be found between nearly any organism when resources are restricted, but is highlighted in this bin with organisms that are territorial and solitary, for example wolverines, lynx, hummingbirds, wasps, etc.…
Mutualism	Mutualism is most easily seen in the interaction between the insects in organism group 4 and any of the flowering plants, but can also be found in the birds that spread the fruiting plants seeds, fungal spores being spread by flying squirrels, etc.
Commensalism	Commensalism can be found in the animals that take shelter in plants, like the squirrel, porcupine, birds, reptiles, amphibians, etc.
Parasitism	Parasitism is found in the tick, but also plants like spotted coral root and paintbrush.

This lesson is broken into two parts, the first focusing on predator/prey interactions and the second focused on other interaction types. Both lesson sections follow the same frame work, but are presented separately below.

Predator/Prey Interactions

Set-up

- To make this activity more phenomenon-based we suggest that you leave the vocabulary to the end of each section (predator, prey.)
- Explain that the students will be stepping into the role of an organism from the Utah Mountain Ecosystem, and try to understand how their organism interacts with the other organisms it encounters.
    - Ask the students for examples of the ways they think the organisms will interact with each other. The goal is to discuss the idea of organisms eating each other, so when a student mentions this type of interaction focus on that comment and explain that the students will begin by looking at interactions that are based on food.
    - Ask the students if all organisms need food to fuel their lives. If needed, remind the students that even plants need food, but typically create it for themselves.
- Instruct the students that they will now create matches between their organism and an organism that they would eat, or that would eat them.
- Distribute the organisms, 1 per student.
    - This activity can be done as a class to save time, by preselecting a few examples of predators and prey and discussing what each eats. If you choose this route it can be helpful to choose organisms that highlight that predator and prey designations can change.
    - Give the students a few moments to read the label on their organism (located on the back of each specimen.) Ask them to focus on what their organism eats ("food source" section on the specimen labels), and what eats their organism ("eaten by" section on the specimen labels.)

Activity

- Depending on your classroom, there are two ways to conduct the next part of the exercise. If your classroom does well with group interactions choose option 1, if they do better without choose option 2.
    - Option 1
        - Ask your students to mingle with the rest of the class, looking for a "eating/being eaten by" match (i.e. students want to create pairs based on one of the organisms eating the other.) Basically, creating a pair where one is a predator and one is prey (without using those terms.)
            - It may help to give an example; a bear could match with a fish or fruit, a chipmunk could match with a gambel oak or a hawk, any of the invertebrates in the Organism Group 2 riker could match with a bird or a fruiting plant or any of the invertebrates in the other group rikers.
            - If your students need more structure, split the class in half. Ask one half to stand in a circle around the edges of the class, and have the other half circulate until they find a match (an organism that they eat or that eats them.)
    - Option 2
        - Lay out an assortment of organisms around your classroom, equaling or exceeding the number of students, in addition to the organisms you've distributed to your students.
        - Ask your students to search out a "eating/being eaten by" match from the organisms laid out around the class (i.e. students want to create pairs based on one of the organisms eating the other.) Basically, creating a pair where one is a predator and one is prey (without using those terms.)
            - It may help to give an example; a bear could match with a fish or fruit, a chipmunk could match with a gambel oak or a hawk, any of the invertebrates in the Organism Group 2 riker could match with a bird or a fruiting plant or any of the invertebrates in the other group rikers.
- Give the teams a set amount of time to complete the activity. We suggest around 5 minutes.
- Once the students have all found a match, ask them to repeat the activity with each student switching their role of eating or being eaten in the next match. For example, if

their organism was the one being eaten in the first match, ask them to find an organism to eat in the second match.

- You may find that some of the organisms have trouble finding a match on the second iteration of the activity, mostly with plants not finding something that they eat. That is ok, and gives the opportunity to mention plants as typically not eating other organisms (and a good lead in to the next activity on energy cycling.)

Discussion

- Ask the students what they noticed during the activity.
  - Did they notice any patterns?
  - Would they group the organisms in any way based on the activity?
  - Were there any organisms that were easier to match, or harder to match?
- Reveal the vocabulary of predator and prey.
  - Discuss whether the students were already familiar with these terms.
    - If so, were they surprised by some of the organisms that could be described as predators or prey?
    - Did all of the organisms considered predators hunt their food?
- Have the students record the results of their activity in the worksheet, "Ecosystem Interactions – Utah Mountains" under Activity 1.

Competition/Cooperation/Symbiotic Interactions

Set-up

- To make this activity more phenomenon-based we suggest that you leave the vocabulary to the end of each section (competition, cooperation, mutualism, commensalism, parasitism, symbiosis)
- Explain that the students will again be stepping into the role of an organism from the Utah Mountain Ecosystem, and exploring other types of interactions.
  - Ask the students for examples of organism interactions, beyond predator/prey interactions. The goal is to get them thinking about the vast diversity of interactions an organism might have with other organisms, so brainstorming is great.

- Instruct the students that they will now create groups based on the types of interactions they've read about on their labels or know about from previous knowledge of the organism they've been assigned.
- Your students can retain the organism they used in the first half of this lesson or you can distribute new organisms at this point.
    - This activity can be done as a class to save time, by preselecting a few examples of cooperative/competitive/mutualistic organism interactions to discuss as a class.
    - Give the students a few moments to review the label on their organism (located on the back of each specimen.) Ask them to look for clues about the other interactions the organism engages in, these are mostly found in the "relationships" section and the notes at the bottom of the labels. If the students have previous knowledge, encourage them to include it in their decision making.

Activity

- Depending on your classroom, there are two ways to conduct the next part of the exercise. If your classroom does well with group interactions choose option 1, if they do better without choose option 2.
    - Option 1
        - Ask your students to mingle with the rest of the class. Have them discuss the interactions that their organisms engage in and break into groups of similar types of interactions.
            - It may help to give an example; deer, wolves, and sparrows all live and feed in groups, or oyster mushrooms, black bear, and bobcats are all territorial, etc.
            - If your students need more structure, break the class into 2 or 3 groups. Then have each group break itself into at least 2 groups based on how their organisms interact.
    - Option 2
        - Lay out an assortment of organisms around your classroom, equaling or exceeding the number of students, in addition to the organisms you've distributed to your students.
        - Ask your students to search out an interaction match, any organism that interacts with other organisms in a similar way.

- Give the teams a set amount of time to complete the activity. We suggest around 8 minutes.
- Have your students record their group and the reasons for their group on the worksheet, "Ecosystem Interactions – Utah Mountains."

Discussion

- Ask each group to explain the pattern of interaction they found within their organisms that lead them to create that group.
    - The goal is to highlight the main patterns of cooperation and competition within the group's selections. This can be done in two ways, depending on time and what works best for your class.
        - If you need to move more quickly, you can begin to sort the groups as they explain the reason for their groups. Move the competitors to one side and the cooperators to the other side. Once all the groups have been sorted, ask the students if they can figure out the pattern that lead them to be sorted, leading the discussion to the end result of working together or working against each other.
        - If you have more time, ask the students to create two groups based on the interactions of each group. Ask them to explain their logic for the two groups that they created. It typically takes around 2 -3 tries for the students to get into groups of cooperators and competitors, if it is taking longer you may want to help guide the groups.
- Reveal the vocabulary of cooperation and competition.
- Have the students record the results of their activity in the worksheet, "Ecosystem Interactions – Utah Mountains" under Activity 2.

Symbiotic Interactions

- Ask the students if the interactions they observed were between different species or within the same species. Explain that the terms cooperation and competition can refer to either type of interaction, but that scientists have specialized terms for the relationships between different species. The overarching term for relationships between two different species is called symbiosis, with three specific types based on the outcomes for the organisms involved.
- Create a 3x3 grid on the board.

- Ask the students if a wild organism is likely to engage in an interaction that is not at least potentially beneficial to that organism. Help direct the conversation to the determination that wild organisms typically don't actively try to harm themselves.
- Explain that since wild organisms typically don't act to harm themselves, it can be assumed that at least one organism is trying to benefit from any given interaction.
    - Label the first column of your grid Organism A.
    - Add a + sign to each of the rows below Organism A, explain that the plus sign indicates that organism A is benefiting from the interaction.
    - Label the second column of your grid Organism B.

- Ask the students what the possible outcomes are for Organism B in its interaction with Organism A.
    - The goal is for students to understand that an organism can benefit, be harmed, or be unaffected. Most examples can be filtered into one of these three categories.
    - As each of the three types of interactions are discussed, add a symbol in a row for Organism B.
        - If Organism B is benefited from the interaction, insert a "+".
        - If Organism B is harmed from the interaction, insert a "–".
        - If Organism B is benefited from the interaction, insert a "0".
- Ask the students if they saw examples of these types of interactions in the organisms they've been studying, or know of examples from their previous experiences. See examples in the Background section if needed.
- Add the vocabulary terms of Mutualism, Parasitism, and Commensalism at appropriate places along the rows of the chart. The finished chart should appear as below.

	Organism A	Organism B
Mutualism	+	+
Parasitism	+	–
Commensalism	+	0

- Have the students record the discussion and their observations in the worksheet "Ecosystem Interactions – Utah Mountains."

Ecosystem Interactions – Across the World

Your students have discovered interactions that occur in the Utah Mountain Ecosystem, but what about other ecosystems? This next section gives your students a chance to find out whether these patterns hold true around the world. Each student, or group of students, will be given an ecosystem to investigate. Their task is to research some of the organisms that live there and determine if the patterns of interactions are the same as those found in our mountains. This can be done as individuals or as groups, and in class or as a take home assignment.

- Ask the students if they think that they would find different patterns of interactions in different ecosystems.
    - If so, what do they think would be different?
- Explain that the students will be investigating another ecosystem to see if they find the same pattern of interactions.
- You can assign ecosystems to the students, or have them choose their own.
    - If assigning ecosystems, we suggest:
        - Coral reef (the Great Barrier Reef in Australia, or the coral reef in Belize)
        - Tropical rainforest (the Amazon River Basin or the Congo River Basin)
        - Desert (Death Valley, the Gobi Desert, Atacama Desert)
        - Arctic Tundra (North Pole)
        - Marine (deep sea, kelp forests, tide pool, salt marsh, mangrove)
        - Wetland (Everglades, Okefenokee Swamp, Pantanal wetlands, Kakadu wetlands)
        - Grassland (savanna, steppes, paramo)
- Have the students record their findings in worksheet, "Ecosystem Interactions – Across the World."
- Discuss the results with the students.
    - Did anyone find that there were organisms that were neither predator or prey?
    - Did anyone find organisms that competed or cooperated?
    - Did anyone find examples of mutualism or other types of symbiosis?
    - Record the answers on the board to reinforce that these patterns are universal across all of Earth's ecosystems.

Assessment

Students should demonstrate and understanding that organisms, regardless of the ecosystem, engage in the same patterns of behaviors. Students should further demonstrate an understanding that these behaviors fall into distinct categories based on what they eat or eats them, and on how they interact with the other organisms and populations in their ecosystem. Informal observations can be made as students are working; observe how they participate in discussions, if they are engaged, etc. Make anecdotal notes of students' verbal responses during discussions. The worksheets can also be used as either a note of participation, understanding, or critical thinking.

Extensions

- The Michigan Science Teaching and Assessment Reform website has a few great lessons on ecosystems. Unit 6.6 Lesson 1 goes over the ecosystems of Michigan and the interactions found between the organisms that live there. PDF's can be found on the USB or at the following link: http://mi-star.mtu.edu/i/lp/6.6_l01_unitopener.pdf

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Ecosystem Interactions – Utah Mountains

Name(s): _____ **Date:** _____

Activity 1

Match 1

Your organism:	**Your match:**
Which organism that was eaten in this match?	

Match 2

Your organism:	**Your match:**
Which organism that was eaten in this match?	

What is the scientific term for organism that is being eaten? _____

What is the scientific term for the organism that is eating another organism? _____

Activity 2

Your organism:
Organisms in your group:
Why did you group these organism's interactions together?

What are the two main types of interactions? _____ **&** _____

Which of the two main types of interactions does your group use? _____

Ecosystem Interactions – Utah Mountains

Can the previous two main types of interactions occur between individuals of the same species AND organisms from different species? _____

What is the scientific term for interactions that occur between organisms of different species?

_____

Fill in the following chart that illustrates the three types of interactions that can occur between organisms of different species.

What do each of the symbols used above mean?

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Ecosystem Interactions – Across the World

Name(s): _____ **Date:** _____

Which ecosystem are you studying? _____

What are some of the non-living or abiotic characteristics of this ecosystem? For example: climate (temperature, precipitation, wind, seasons), terrain (mountain, valley, ocean, river), etc.

_____

_____

_____

_____

What are some of the living or biotic characteristics of this ecosystem? For example: plants, mammals, birds, insects, fungi, fish, algae, etc.

_____

_____

_____

_____

Predator / Prey Patterns of Interactions

Using the chart below, record some examples of the predator and prey interactions you observed in the ecosystem you studied. If you find any organisms that you believe do not follow the pattern of being either predator or prey, record them in the last column.

Predator Examples	Prey Examples	Neither Predator nor Prey Examples

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Ecosystem Interactions – Across the World

Cooperation / Competition Patterns of Interactions

Using the chart below, record some examples of the cooperative and competitive interactions you observed in the ecosystem you studied. If you find any organisms that you believe do not follow the pattern of either cooperating or competing with other organisms record them in the last column.

Cooperation Examples	Competition Examples	Neither Cooperation nor Competition Examples

Symbiotic Patterns of Interactions

Review the definitions of symbiotic relationship types, then record your observations below.

Symbiosis (Symbiotic relationships): _____

_____

Mutualism: _____

_____

Parasitism: _____

_____

Commensalism: _____

_____

Ecosystem Interactions – Across the World

Name(s): _____ **Date:** _____

Symbiotic Patterns of Interactions

Using the chart below, record some examples of the symbiotic interactions you observed in the ecosystem you studied. If you find any organisms that you believe do not fit into one of the following categories record it below.

Mutualism (+,+)	Parasitism (+,–)	Commensalism (+, 0)

Did you find any examples of symbiotic organism interactions that did not fit in one of the above categories? If so, record them here. _____

_____

Did you find the same patterns of interactions in the ecosystem you studied and the Utah Mountain ecosystem? _____

Why do you think you did or did not find the same patterns of interactions? _____

_____

_____

_____