Bio Box

Monte L. Bean
Life Science Museum
Brigham Young University

Protect the Wildlife
see complete details on pg. 64

Food Webs
find materials and directions, plus curriculum tie-ins on pg. 25

Species Interaction
learn how different organisms rely on each other on pg. 21

ecosystems

Designed and Produced by the Brigham Young Univerisity
Monte L. Bean Life Science Museum

Monte L. Bean
Life Science
Museum
Brigham Young University

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A Note From The Director

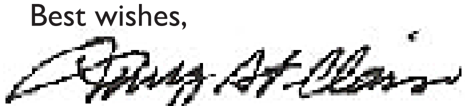
Greetings!

The M.L. Bean Life Science Museum at Brigham Young University is committed to using its vast biological collections to support the museum's mission to promote world class teaching and research. Furthermore, we are fully dedicated to working closely with our public and private school colleagues to help secondary level students more fully appreciate the patterns and processes of living systems. As part of our commitment, the museum, through its education programs, offers resources to support educators in their efforts to more effectively teach our children. This "Bio-Box" is one element of that program. It has been designed with both educators and students in mind.

- Adaptations
- Ecosystems
- Classification

We are convinced that you will find that the "Bio-Box" program will provide invaluable support for your teaching efforts. We invite you to take advantage of the other education-related services offered by The Bean Life Science Museum, including exhibit tours, live animal shows (in house and outreach), and Nature Experienceships. Please visit our website (mlbean.byu.edu) for more information on these and other programs.

Best wishes,



Larry L. St. Clair
Director

User Registry

Date	Name	Group [Age]

Using the Guidebook:

Using the Guidebook: This diagram will help familiarize you with the layout and information codes in the "Bio Box" series guidebooks. The books are intended as idea sources, not lesson plans--and we need your notes and feedback to keep improving them.

Preparation Level

- Very Little Prep.
- Gathering/Re-arranging
- Background Work

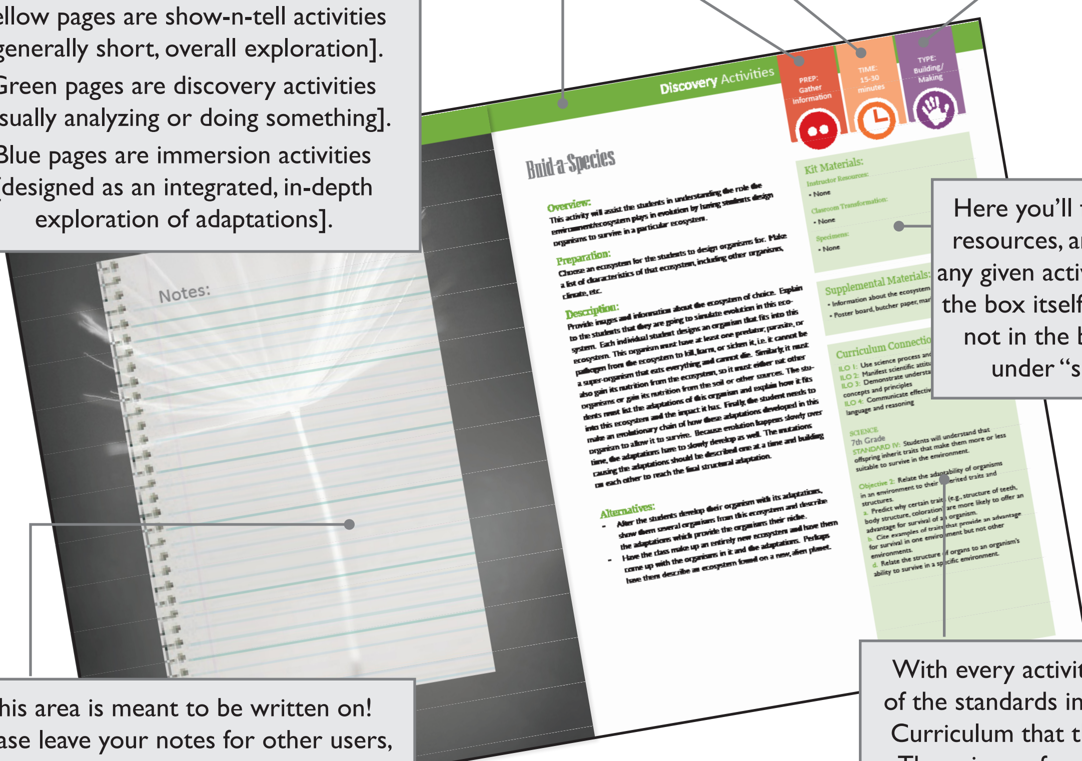
Time Requirement

- About 15 Minutes.
- About Half an Hour.
- About 45 Minutes.
- About an Hour.
- Multiple Class Periods

Activity Type

- Building/Making
- Exploring/Analyzing
- Integrated

The stripe across the top of each activity page is a color code:
Yellow pages are show-n-tell activities [generally short, overall exploration].
Green pages are discovery activities [usually analyzing or doing something].
Blue pages are immersion activities [designed as an integrated, in-depth exploration of adaptations].



Here you'll find a list of all the materials, resources, and specimens you'll need for any given activity. The area is broken up like the box itself, and anything you need that's not in the box will be clearly indicated under "supplementary materials."

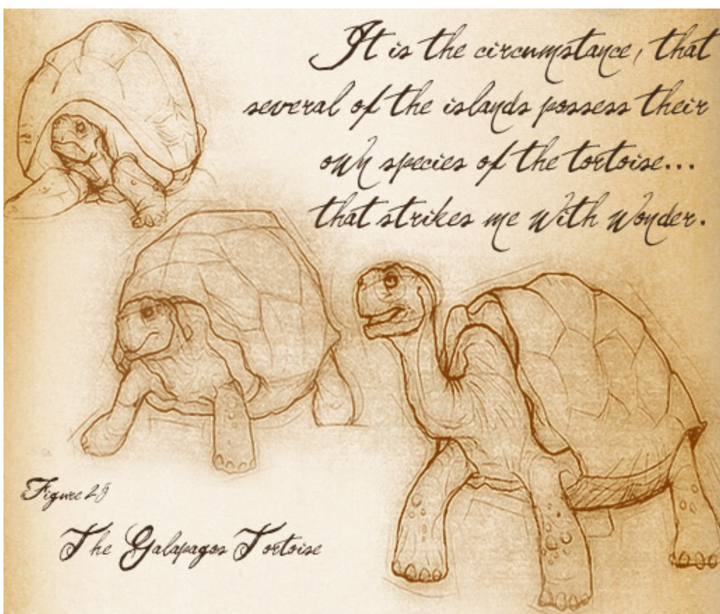
This area is meant to be written on! Please leave your notes for other users, as well as for us at the museum. What worked? What didn't work? How did you adapt the activity? What other great ideas do you have? We want to know!

With every activity is a brief overview of the standards in the Utah State Core Curriculum that the activity addresses. The primary focus in development of Science, but cross curriculum standards are represented here as well.

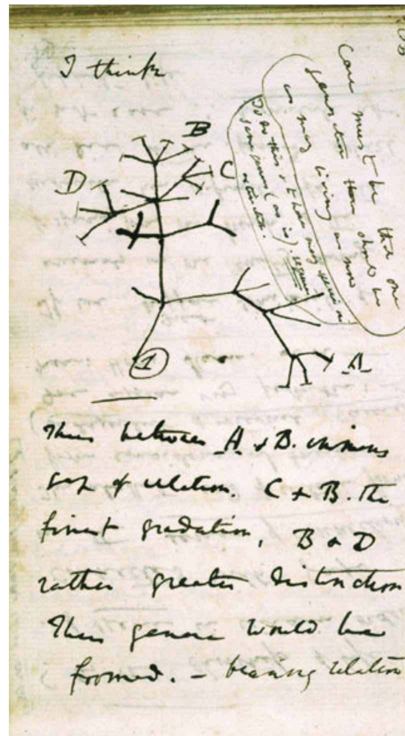
Did you remember your field notebook?

The Scientific Method involves the process of making observations, formulating hypotheses, making predictions and designing experiments based on the hypotheses. All of these steps need to be carefully recorded. This process aids the scientist and others in further research.

As students use this bio box, it is important for them to use a field notebook to keep track of everything they do. Following each activity, students should take some time to record their observations and everything they have learned. The next step is for each student to create a hypothesis based on the observations. Each hypothesis must be testable and students will then come up with experiments to test the hypothesis. These should be recorded in the proper place in the field journal. This process will help students to think more like a scientist.



Sketches and description out of Darwin's Field Notebook. Here he describes the Galapogas Tortoise.



Sketches and description out of Darwin's Field Notebook. This is Darwin's first diagram of an evolutionary tree.

Activity Index...

Preparation Level

- 20 Questions
- Becoming Biologists
- Species Interaction
- Observing Biology in Action
- Crash
- Layers
- Food Web inquiry
- What's For Dinner?

- Symbiosis
- Species Protection

- Essential Elements
- Succession Game
- Coevolution
- The Hunt
- Speciation

Time Requirement

- 20 Questions
- Observing Biology

- Becoming Biologists
- Species Interaction
- Symbiosis

- Essential Elements
- Layers
- Food Web Inquiry
- What's For Dinner

- Succession
- Coevolution
- The Hunt
- Speciation

- Crash
- Species Protection

Activity Type

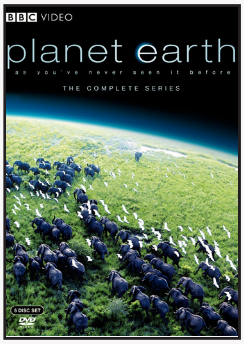
- Essential Elements

- 20 Questions
- Becoming Biologists
- Species Interaction
- Observing Biology
- Symbiosis
- Crash
- Layers
- Food Web Inquiry
- What's For Dinner

- Succession Game
- Coevolution
- The Hunt
- Speciation
- Species Protection

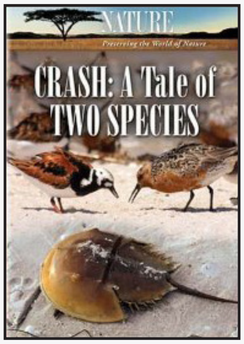
Resource Index...

Planet Earth



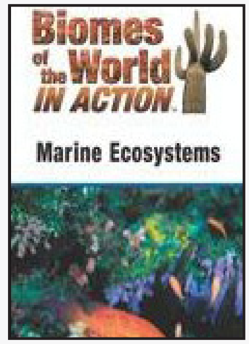
Planet Earth, a groundbreaking TV series on Discovery Channel, explores the marvels of our planet. See stunning video footage of the natural world.

CRASH: A Tale of TWO Species



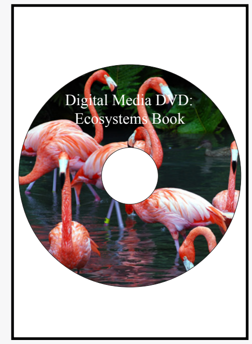
In the film Crash: A Tale of Two Species, filmmaker Allison Argo tells the story of nature's amazing ability to create fragile connections among the most unexpected creatures, and of our potential as humans to destroy those connections — or restore them.

Biomes of the World



Biomes of the World in Action is a fun, informative series that takes students on a fast-paced, eco-adventure around the world exploring the many characteristics that make these large regions of the world different from each other.

Digital Media DVD



This DVD has a PDF version of this guide and digital copies of all images and files used to allow teachers to display and use the images and files in digital format.

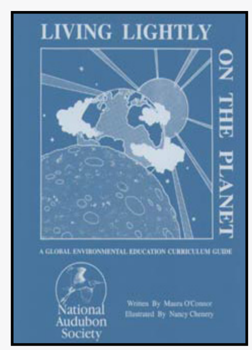
Invasive Species of the Great Lakes

Offering an introduction to a long-standing problem, this kit will help your students understand the effect of invasive species and why we should help to prevent their spread.

How is a Food Web Organized?

This is a game-like activity about the feeding patterns of members in a community. Introduce food webs and food chains using this innovative lab.

Living Lightly on the Planet Vol. I&II



Activities help students understand complex flows of nutrients and energy in ecological systems and the sources and solutions to pollution problems on a local and global basis.

Specimen Index...

Cougar

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
- What's For Dinner?
- Species Protection

Coyote

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
- What's For Dinner?
- Species Protection

Mormon Crickets

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
- What's For Dinner?
- Species Protection

Dark-eyed Junco

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
- What's For Dinner?
- Species Protection

Ground Squirrel

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
  - Arctic Ecosystem
- What's For Dinner?
- Species Protection

Golden Eagle

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
  - Arctic Ecosystem
- What's For Dinner?
- Species Protection

Gambel's Quail

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
- What's For Dinner?
- Species Protection

Screech Owl

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
- What's For Dinner?
- Species Protection

Deer Mouse

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
- What's For Dinner?
- Species Protection

Pronghorn

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
- What's For Dinner?
- Species Protection

Mexican Free-tailed Bat

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
- What's For Dinner?
- Species Protection

Sphinx Moth

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
- What's For Dinner?
- Species Protection

Gopher Snake

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
- What's For Dinner?
- Species Protection

Grasshopper

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Desert Ecosystem
  - Arctic Ecosystem
- What's For Dinner?
- Species Protection

Arctic Fox

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Arctic Ecosystem
- What's For Dinner?
- Species Protection

Polar Bear

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Arctic Ecosystem
- What's For Dinner?
- Species Protection

Mosquito

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Arctic Ecosystem
- What's For Dinner?
- Species Protection

Moth

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Arctic Ecosystem
- What's For Dinner?
- Species Protection

Short-tailed Weasel

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Arctic Ecosystem
- What's For Dinner?
- Species Protection

Musk Ox

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Arctic Ecosystem
- What's For Dinner?
- Species Protection

Crinkled Snow Lichen

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Arctic Ecosystem
- What's For Dinner?
- Species Protection

Wolverine

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Arctic Ecosystem
- What's For Dinner?
- Species Protection

Ptarmigan

- 20 Questions
- Becoming Biologists
- Species Interactions
- Essential Elements
  - Arctic Ecosystem
- What's For Dinner?
- Species Protection

Resource Usage:

	Print Resources									Multimedia Resources			Other						
	Specimen Cards	Ecosystem Pictures	Food Web Expert Cards	Food Web Question Cards	Dinner Cards	Menu Cards	Symbiosis Cards	Succession Game Cards	Living Lightly on the Planet	Planet Earth DVDs	CRASH DVD	Biomes of the World	Yarn	Transparency Sheets	Coevolution Game Kit	The Hunt Game Kit	Speciation Game Kit	Invasive Species Kit	Food Web Kit
20 Questions	●																		
Becoming Biologists	●																		
Species Interaction	●																		
Essential Elements of Life	●												●						
Observing Biology in Action										●									
Layers		●												●					
Food Web Inquiry		●	●	●															
What's For Dinner					●	●													
Symbiosis							●												
Crash											●								
Succession Game								●											
Coevolution															●				
The Hunt																●			
Speciation																	●		
Species Protection																			
Additional Resource Activities:																			
Living Lightly on the Planet									●										
Invasive Species Activity																		●	
Food Web Activity																			●

Specimen usage:

	Cougar	Coyote	Mormon Crickets	Dark-eyed Junco	Ground Squirrel	Golden Eagle	Gambel's Quail	Screech Owl	Deer Mouse	Pronghorn	Mexican Free-tailed Bat	Sphinx Moth	Gopher Snake	Arctic Fox	Polar Bear	Mosquito	Moth	Grasshopper	Short-tailed Weasel	Musk Ox	Crinkled Snow Lichen	Wolverine	Ptarmigan
20 Questions	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Becoming Biologists	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Species Interaction	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Essential Elements of Life	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Observing Biology in Action																							
Layers																							
Food Web Inquiry																							
What's For Dinner?	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Symbiosis																							
Crash																							
Succession Game																							
Coevolution																							
The Hunt																							
Speciation																							
Species Protection	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Additional Resource Activities:																							
Living Lightly on the Planet																							
Invasive Species of the Great Lakes																							
How is a Food Web Organized																							
Biomes of the World in Action	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Curriculum Connections...

You can use Bio Box activities to teach the Utah State Core Curriculum! This kit contains activities that address standards from the science curriculum (observing and predicting). These charts will help you find activities that relate to the content you need to teach for your grade level. For a list of curriculi, go to http://www.schools.utah.gov/curr/sci/secondary/default.htm.

	ILO				7th Lang. Arts		SEVENTH SCIENCE					H.S. BIOLOGY																			
	1	2	3	4	Std.		STANDARD IV					STANDARD I														STD. IV		STD. V			
							1	OBJ. 2				OBJ. 1					OBJ. 2				OBJ. 3					1	2	OBJ. 1			2
					2	3	c.	a.	b.	c.	d.	a.	b.	c.	d.	e.	a.	b.	c.	d.	a.	b.	c.	d.	e.	b.	d.	a.	b.	c.	b
20 Questions	●	●	●	●			●	●	●	●	●																				
Becoming Biologists	●	●	●	●				●	●	●	●										●			●							
Species Interaction	●	●	●	●								●									●	●		●	●	●	●				
Essential Elements of Life	●	●	●	●								●	●	●			●	●		●	●	●		●	●						
Observing Biology in Action	●	●	●	●										●	●		●	●		●	●			●	●						
Layers	●	●	●	●								●										●	●								
Food Web Inquiry	●	●	●	●								●					●	●			●			●							
What's For Dinner?	●	●	●	●								●	●	●	●		●				●										
Symbiosis	●	●	●	●																	●	●									
Crash	●	●	●	●								●		●	●	●			●	●	●			●	●						
Succession Game	●	●	●	●													●	●			●			●							
Coevolution	●	●	●	●				●	●		●																	●	●		●
The Hunt	●	●	●	●										●	●						●		●		●						
Speciation	●	●	●	●				●	●		●															●		●	●	●	
Species Protection	●	●	●	●	●	●		●	●		●																●	●	●		
Additional Resource Activities:																															
Living Lightly on the Planet	●	●	●	●													●	●		●					●						
Invasive Species of the Great Lakes	●	●	●	●																	●										
How is a Food Web Organized	●	●	●	●								●	●	●	●						●										
Biomes of the World in Action	●	●	●	●	●	●		●	●		●									●						●	●				

	20 Questions	Becoming Biologists	Species Interaction	Essential Elements	Observing Biology	Layers	Food Web Inquiry	What's For Dinner?	Symbiosis	Crash	Succession Game	Coevolution	The Hunt	Speciation	Species Protection	Additional Resource
ILO 1	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
ILO 2	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
ILO 3	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
ILO 4	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
7th Lang. Arts Std. 2															●	
7th Lang. Arts Std. 3															●	
SEVENTH GRADE STANDARD IV																
Objective 1 c.	●															
Objective 2.																
a	●	●										●		●	●	
b.	●	●										●		●	●	
c.	●	●														
d.	●	●										●		●	●	
H.S. BIOLOGY STANDARD I																
Objective 1																
a.			●	●		●	●	●		●						●
b.				●				●								●
c.				●	●			●		●			●			●
d.					●			●		●			●			●
e.										●						
Objective 2																
a.				●	●		●	●			●					●
b.				●	●		●				●					●
c.										●						
d.				●	●					●						●
Objective 3																
a.		●	●	●	●		●	●	●	●	●		●			●
b.			●	●		●			●							
c.						●							●			
d.		●	●	●	●		●			●	●					
e.			●	●	●					●			●			●
STANDARD IV																
Objective 1 b.			●											●		
Objective 2 d.			●												●	
STANDARD V																
Objective 1																
a.												●		●	●	
b.												●		●	●	
c.														●		
Objective 2																

Resource Notes:

PREP: Minimal Prep.

TIME: 15-30 minutes

TYPE: Explore/ Analyze

20 questions

Overview:

These ideas offer a variety of ways for students and teachers to familiarize themselves with the specimens and explore the adaptations illustrated by the specimens in this kit.

Suggested Activities:

- Have the students either sit in a circle or at their desks with paper and writing utensils. Hold up a specimen without any explanation. Choose a question, or several based on the information on the specimen card: "What ecosystem does this come from?" "What interesting adaptations does this specimen have?" etc. and have the students write their answers. Call on several to share their predictions and reasoning, if desired. Then explain the answer and move on to the next specimen.

- With the students sitting in a close circle, hold up a specimen, again with no explanation. Call on students to ask yes or no questions to come up with a description of the specimen, it's ecosystem, diet, habitat, and adaptations. You might assign someone to record on paper or the board what is learned through each question, then compare the summary they come up with to the information provided on the card.

- Pass a specimen out to each student, along with the Specimen Card that accompanies it. Allow them a few minutes to familiarize themselves with their specimen. Then collect the cards, shuffle them, and choose one secretly. Have all the students stand with their specimens and play an elimination game [played like the board game "Guess Who?"] Choose one student to be "it" and have them ask questions ["Does this specimen have fur?"] If the answer is yes, those students whose specimen doesn't have fur sit down, and so on until the student guesses the specimen on the chosen card correctly.

Kit Materials:

Instructor Resources:

- Specimen Cards

Classroom Transformation:

- none

Specimens:

- All

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE
7th Grade
STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 1: Compare how sexual and asexual reproduction passes genetic information from parent to offspring.
c: Cite examples of organisms that reproduce sexually and those that reproduce asexually.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a: Predict why certain traits are more likely to offer an advantage for survival of an organism.
b: Cite examples of traits that provide an advantage for survival in one environment but not other environments.
c: Cite examples of changes in genetic traits due to natural and manmade influences.
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

PREP: Minimal Prep.

TIME: 20-40 minutes

TYPE: Explore/ Analyze

Becoming Biologists

Kit Materials:

Instructor Resources:

• Specimen Cards

Classroom Transformation:

• none

Specimens:

• All Specimens

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a: Predict why certain traits are more likely to offer an advantage for survival of an organism.
b: Cite examples of traits that provide an advantage for survival in one environment but not other environments.
c: Cite examples of changes in genetic traits due to natural and manmade influences.
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

Biology Core

STANDARD I: Students will understand that living organisms interact with one another and their environment.

Objective 3: Describe how interactions among organisms and their environment help shape ecosystems.
a: Categorize relationships among living things according to predator-prey, competition, and symbiosis.
d: Investigate an ecosystem using methods of science to gather quantitative and qualitative data that describe the ecosystem in detail.

Overview:

This activity helps students explore adaptations by providing specimens to the students and asking them to research the organism.

Suggested Activities:

- Each student or group of students receives a specimen with the associated Specimen Card. The student is then instructed to research the organism. The research should include information about the habitat, the diet, the predators, the challenges faced by the organism, and adaptations that the organism has to survive in its environment. After the students have done this research, going above and beyond what is written on the specimen card, each student/group prepares a short presentation to share how the organism fits into its ecosystem.

- Small groups of students are given a specimen without the specimen card. These students are then instructed to study the organism, hypothesize about the habitat of the organism, and make a list of interesting attributes of the organism which allow it to survive in its hypothesized ecosystem. The students are then given the card to determine if their hypotheses are correct. Finally, the students choose one interesting adaptation of the specimen, do independent research about this adaptation, and write a short paper describing the benefits.

PREP: Minimal Prep.

TIME: 20-40 minutes

TYPE: Explore/ Analyze

Species Interaction

Overview:

Theis activity gets students thinking about the connectedness of life.

Description:

- Distribute threee Specimen Cards to each student or group of students. Have each student study the information on the card carefully and if necessary, do research on these organisms. At this point each student or group is to determine how each of their specimens impacts the other specimens. The interactions may be direct or indirect with missing links in between. If there is no direct interaction, have the students determine the missing links between these organisms. Once the students have identified the connections between the organisms, have them determine how changes in the environment will impact each of the species. Aslo determine how increases and decreases in the population of one species will affect the others. Finally determione the impact of human choices on these species. This activity should help students realize that even organisms from different ecosystems can have a significant impact on each other.

Kit Materials:

Instructor Resources:

• Specimen Cards

Specimens:

• All

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

Biology Core

STANDARD I: Students will understand that living organisms interact with one another and their environment.

Objective 1: Summarize how energy flows through an ecosystem.

a: Arrange components of a food chain according to energy flow.

Objective 3: Describe how interactions among organisms and their environment help shape ecosystems.

a: Categorize relationships among living things according to predator-prey, competition, and symbiosis.

b: Formulate and test a hypothesis specific to the effect of changing one variable upon another in a small ecosystem.

d: Investigate an ecosystem using methods of science to gather quantitative and qualitative data that describe the ecosystem in detail.

e: Research and evaluate local and global practices that affect ecosystems.

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes.

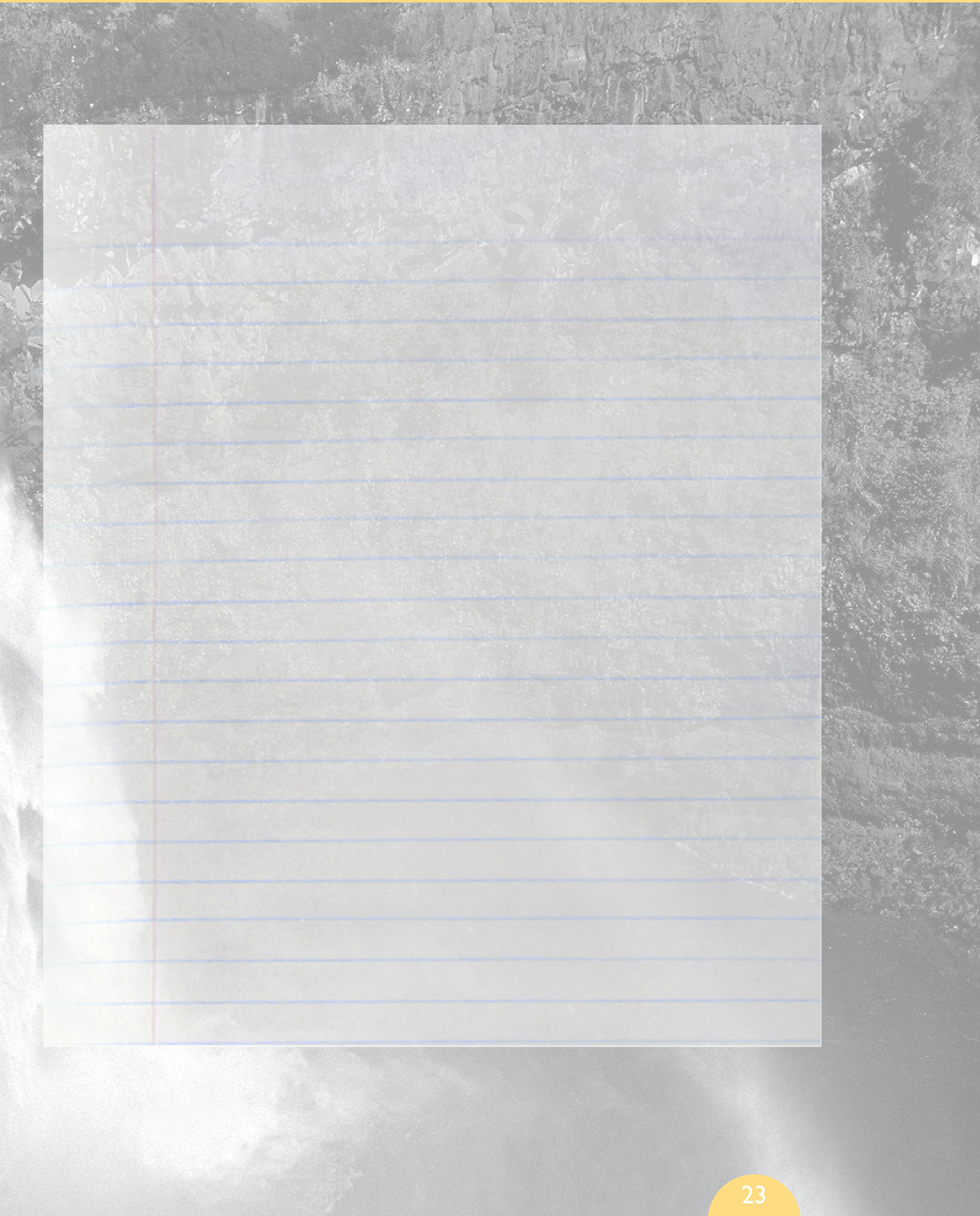
Objective 1: Relate principles of evolution to biological diversity.

a: Describe the effects of environmental factors on natural selection.

Objective 2: Cite evidence for changes in populations over time and use concepts of evolution to explain these changes.

b. Identify the role of mutation and recombination in evolution.

Notes:



PREP: Prepare Lesson

TIME: 45-60 minutes

TYPE: Exploring/ Analyzing

Essential Elements of Life

Overview:

Students will reconstruct the interconnectedness of an ecosystem in this activity. Students will be given specimens to study and the class will come together and develop a food web reflecting symbiotic relationships as well.

Description:

The Bio Box contains specimens from two different ecosystems, the Utah desert and the arctic tundra. Choose one ecosystem and assign each speicmen to individual students or groups. Either in the first part of the class period associated with this activity or as homework before class, each student or group researches their species to identify where it gets its essential elements and compounds (which for this exercise we will limit to carbon, nitrogen, oxygen and water) and what interactions it has with other organisms in the ecosystem. Every student is given a handout listing off the various organisms and resources. Have several pieces of white string representing energy transfer and colored string representing interspecific relationships. Red yarn represents parasitism, blue yarn represents mutualism and yellow yarn represents competition.

Start with a discussion or lesson on the nutrient cycles of the nutrients mentioned above. Make sure students understand the critical role each of these elements or compounds play in life. Additionally make sure the students understand the different relationships including mutualism, competition, parasitism, and predation. Have the students research their organism to determine the source of their nutrients as well as the relationships they have with other members of the ecosystem. (For predators, most of the nutrients will come from their prey and for producers, most will come from the soil.)

After enough time has been given, have the class stand in a circle with students or groups holding their specimen and a sign with the name and image of the species. Start with one group and have them share where their specimen gets each of its elements and what other organisms they directly interact with. For each source of its nutrients, a white string is connected from the presenting group to the source of the nutrient, whether it is another organism or an abiotic source such as the atmosphere or a pond. For each relationship with another organism in the ecosystem, the presenting group connects a string of the color associated with the relationship to the other organism(s) involved in this relationship. One member of each group holds one end of all the strings representing nutrient flow or relationships while the other members bring the other ends to the proper locations. Once the first group finishes with their presentation, the next group in the

Kit Materials:

Instructor Resources:

• Several 15 foot strands of white, red, blue, and yellow yarn

Classroom Transformation:

• Arrange room with enough space for the class to stand in a circle

Curriculum Connections:

ILO 1- ILO 4

SCIENCE

Biology Core

STANDARD I: Students will understand that living organisms interact with one another and their environment.

Objective 1: Summarize how energy flows through an ecosystem.
a. Arrange components of a food chain according to energy flow.
b. Compare the quantity of energy in the steps of an energy pyramid.
c. Relate reproductive isolation to speciation.

Objective 2: Explain relationships between matter cycles and organisms.
a. Use diagrams to trace the movement of matter through a cycle (i.e., carbon, oxygen, nitrogen, water) in a variety of biological communities and ecosystems.
b. Explain how water is a limiting factor in various ecosystems.
d. Evaluate the impact of personal choices in relation to the cycling of matter within an ecosystem (e.g., impact of automobiles on the carbon cycle, impact on landfills of processed and packaged foods).

Objective 3: Describe how interactions among organisms and their environment help shape ecosystems.
a. Categorize relationships among living things according to predator-prey, competition, and symbiosis.
b. Formulate and test a hypothesis specific to the effect of changing one variable upon another in a small ecosystem.
d. Investigate an ecosystem using methods of science to gather quantitative and qualitative data that describe the ecosystem in detail.
e. Research and evaluate local and global practices that affect ecosystems.

circle repeats the same process, and so on until each group has gone. An intricate web of yarn should be formed showing the interconnectedness of ecosystems. After the web has been completed, the teacher goes through scenarios where factors change, both biotic and abiotic. The class goes through to determine the effect this has on the ecosystem. For example, temperature drops due to onset of fall. What happens? Insects start to die, plants go dormant or die, birds and other animals that rely on insects have a harder time and many die or migrate, predators of birds either begin to die, migrate, or hibernate, and so on and so forth.

Biotic and Abiotic Factors to Discuss:

- Air Pollution
- Temperature Increase
- Global warming induced draught
- Invasive plant species
- Invasive insect species
- Bees die off
- Bird flu
- Plague
- Deforestation
- Increased Rainfall

Alternatives:

- Assign the construction of the food web as homework. In class have groups share their food webs and collaborate on ideas. Assign each group a change in one of the factors and have them determine the changes in the ecosystem. After enough time has passed to allow all the groups to complete their task, Have each group present their results to the rest of the class.
- Watch the Planet Earth segment associated wtih the ecosystem your class will explore through this activity before beginning. This will give the students a greater understanding of how this ecosystem works.

Notes:

PREP:
Minimal

TIME:
15-30 minutes

TYPE:
Exploring/ Analyzing

Observing Biology in Action

Kit Materials:

Instructor Resources:

- Planet Earth the Complete Series

Supplemental Materials:

- DVD player and projector

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

Biology Core

STANDARD I: Students will understand that living organisms interact with one another and their environment.

Objective 1: Summarize how energy flows through an ecosystem.
c. Describe strategies used by organisms to balance the energy expended to obtain food to the energy gained from the food
d. Compare the relative energy output expended by an organism in obtaining food to the energy gained from the food.
Objective 2: Explain relationships between matter cycles and organisms.
a. Use diagrams to trace the movement of matter through a cycle (i.e., carbon, oxygen, nitrogen, water) in a variety of biological communities and ecosystems.
b. Explain how water is a limiting factor in various ecosystems.
d. Evaluate the impact of personal choices in relation to the cycling of matter within an ecosystem (e.g., impact of automobiles on the carbon cycle, impact on landfills of processed and packaged foods).
Objective 3: Describe how interactions among organisms and their environment help shape ecosystems.
a. Categorize relationships among living things according to predator-prey, competition, and symbiosis.
d. Investigate an ecosystem using methods of science to gather quantitative and qualitative data that describe the ecosystem in detail.
e. Research and evaluate local and global practices that affect ecosystems.

Overview:

By watching video clips of fascinating biological spectacles and answering related questions, students will develop an understanding for science while developing their scientific thinking skills.

Description:

Play the clip or clips you choose from the Planet Earth Collection and have the students answer the associated question in small groups or by themselves. Feel free to come up with other questions as well.

Disc 1:

From Pole to Pole

- A common theme throughout this segment is migration. Why is migration a common strategy? What are the costs and what are the benefits of migration? List a few examples from this segment and describe the specific benefits and costs for these species.

- 34:27-39:20
    - Some ecosystems are in constant flux, like the flooding of the savanna. What impact does the change have on the organisms in this ecosystem? The monkeys that live in that area adapt to their new circumstances by changing their behavior. What problems must be overcome? What options do animals have when their ecosystem changes? What other ecosystems can you think of that undergo change requiring animals to change their behavior?

Mountains

- 3:04-8:09
    - Why do geladas and walia ibex graze together instead of fighting over grazing territory? What type of relationship is this? What are the costs, if any, and the benefits, if any, of this relationship to both organisms?
- 25:47-32:39
    - Hunting is costly, especially in mountainous terrain. Why do you think snow leopards chase their prey down the mountain when a successful hunt results in difficulty bringing it back?

Fresh Water

- 28:21-30:18
    - Lake Baikal is the world's deepest lake. It is very isolated from other lakes and is very ancient. Additionally 80% of its species are endemic, or unique. Because of its biodiversity and unique organisms, Lake Baikal is called the "Galapagos of Russia." Why do you think there are so many unique, or endemic, species in Lake Baikal? What other areas do you expect to have similar levels of endemic species? What does this say about evolutionary driving forces?

Disc 2:

Caves

- 10:44-14:35
    - What is the source of the energy that fuels the ecosystem of Deer Cave? Construct a food web for the deer cave ecosystem.

      "Deer Cave is particularly rich in invertebrate life...The guano is home and food to countless creatures: flies, maggots, beetles, bugs, millipedes, springtails, cockroaches, worms, mites, moths. They make the guano look as if it has a life of its own as it heaves and flows like thick liquid and, if disturbed, the creatures frantically try to bury themselves.

      These animals are in turn fed upon by the cave crickets, centipedes, whip scorpions, true scorpions and spiders. And in their turn, all these provide food for small mammals, frogs and toads."
    - This is an excerpt from an article from the Brunei Times. Use this information to verify and correct the food web that you constructed.
    - In what ways does this ecosystem rely on the sun? In what ways is it unique from most other ecosystems when it comes to the sun? What other ecosystems are similar in this regard?
- 37:21- 40:51
    - In what ways is the ecosystem based off of the extremophile bacteria found in snottites independent of the outside world? In what ways is it linked? How are these bacteria able to form the basis of this ecosystem? Midges, spiders, and gastropods are just a few of the organisms found roaming the caves and eating the microbial colonies. Fish are also frequently found. What adaptations do these organisms require to survive in this environment?

Deserts

- What are the techniques used by desert dwellers to obtain enough water? What are the drawbacks of these techniques? What are the advantages? Does the limitation of water have an impact on the amount of life that can be sustained by an ecosystem? How so?
- What are the challenges of life in the desert? For each of these challenges, describe adaptations desert organisms have to survive.

Disc 3:

Jungles

- 3:50-9:30
    - In the rainforest, light is one of the primary limiting factors. When a hardwood tree falls, plants race to be the recipients of a little direct sunlight. Describe the process of succession and a few of the competitors as described in the video. Who are the ultimate winners? If one type of plant eventually beats out the others, how have these other species survived extinction? Describe their strategy for perpetuation.
- 10:34-15:25
    - What makes fig trees a gathering point for up to 44 species of monkeys and birds? What strategies do different species us to maximize their harvest of figs? What similar foods attract the same kind of attention and what tactics are used to utilize it?

- 22:30-25:34
  - There are many different kinds of fungus that play many different roles in the rainforest ecosystem. Mycorrhizal fungi are critical for the growth and survival of the trees in the rainforest. Mycorrhizal symbioses are present in almost every species of plant. Why do you think plants and fungus put the effort and energy into developing this relationship?
  - In what other ways do fungi play a critical role in the development of the rainforest? How do cordyceps fungi impact the rainforest?
- 30:55-34:08
  - There is a spectrum of evolutionary tactics with specialists on one end and generalists on the other. Generalists are species that are capable of living in a wide variety of environmental conditions and can make use of a variety of different resources whereas specialists have a much narrower range of conditions. What are the advantages of each? What are the disadvantages? Which is likely to be most responsible for biodiversity?

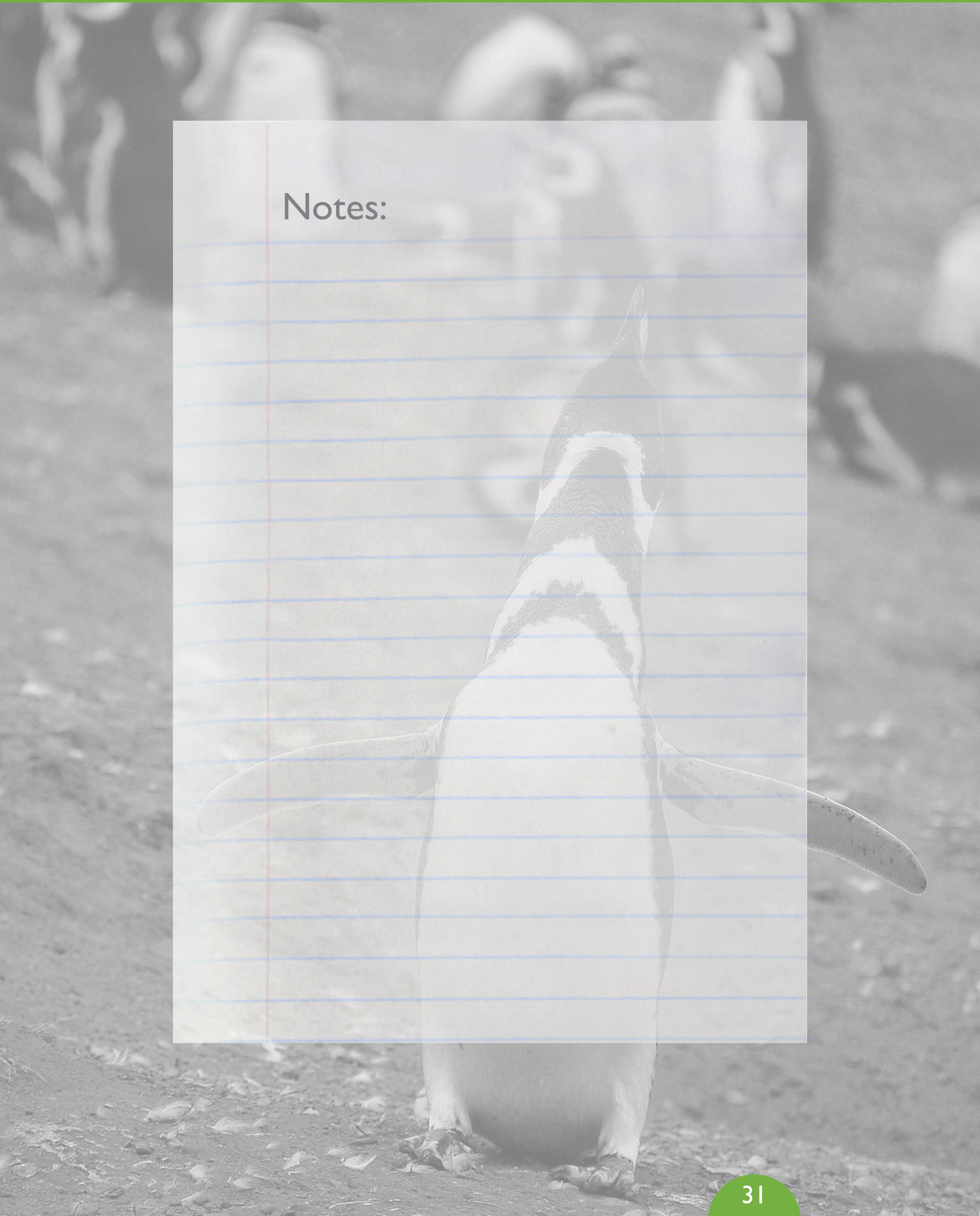
Shallow Seas

- 5:00-7:44, 8:57-12:25
  - Mutualism is a key to many if not most ecosystems. The polyps that form coral are involved in a symbiosis with photosynthetic algae. Coral reefs are thriving ecosystems that paradoxically are surrounded by water low in nutrients making cycling of nutrients much more critical. How does the polyp-algae interaction make it possible for this ecosystem to thrive in an otherwise difficult environment? What are the consequences of this relationship for the other organisms in this ecosystem?
- 23:49-28:45
  - Describe the seasonal cycles. What causes the booms in population? What causes its collapse? What are the abiotic factors involved in the cycle? What are the biotic factors? What impact do the seasonal cycles in the shallow seas have on organisms in nearby and distant ecosystems?

Disc 5:

Saving Species

  - Why is species preservation critical? Are there species that are more critical than othes? How do you determine where the focus needs to be?
  - What are the different motivations for preserving biodiversity? What are the pros and cons to each? What is your motivation for conservation?
- 9:57-11:47
  - How are humans responsible for the demise of frogs, according to this clip? In what other ways do we impact their habitats and ability to survive? What problems have arisen in other ecosystems due to the introduction of non-endemic species by humans?
- 15:13-17:35
  - The walia ibex have been removed from one habitat after another. What has given them the good fortune to have escaped extinction? What are the challenges they still face? For other similar animals or species that are unable to adapt to new environments like the walia ibex, what is their fate? How are humans responsible for the fate of the ibex? What should we do?



Notes:

PREP: Distribute Materials

TIME: 45 minutes

TYPE: Exploring/ Analyzing

Layers

Kit Materials:

Instructor Resources:

- Overhead transparency sheets
- Ecosystem Pictures

Supplemental Materials:

- 1 Erasable marker per student (i.e. Vis-a-Vis)

Alternative Resource Suggestions:

- http://www.fws.gov/klamathfallsfwo/about/ecosystem.jpg
- http://fc.thompson.k12.co.us/~pdd/pwred/pbl/ecosystem-sign.jpg
- http://www.divediscover.whoi.edu/arctic-ecosystem/images/ecosystem.jpg

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

Biology Core

STANDARD I: Students will understand that living organisms interact with one another and their environment.

Objective 1: Summarize how energy flows through an ecosystem.
a. Arrange components of a food chain according to energy flow.

Objective 3: Describe how interactions among organisms and their environment help shape ecosystems.
b. Formulate and test a hypothesis specific to the effect of changing one variable upon another in a small ecosystem.
c. Use data to interpret interactions among biotic and abiotic factors (e.g., pH, temperature, precipitation, populations, diversity) within an ecosystem.

Overview:

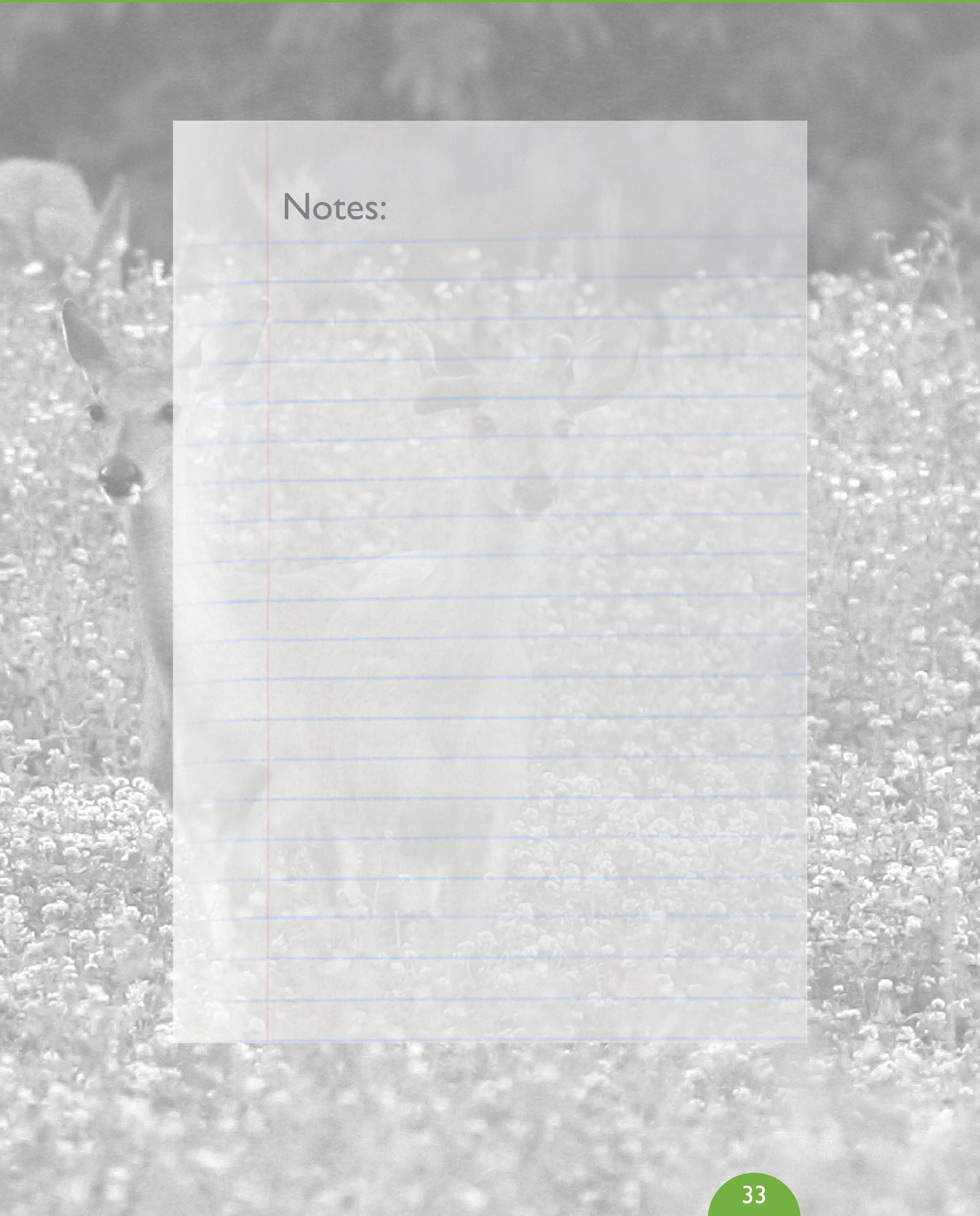
Students will identify Biotic and Abiotic factors in an ecosystem and the relationships that exist among them.

Description:

1. Each student receives a copy of the Ecosystem picture and two transparencies. Have the student place one transparency over the picture. Trace and label everything they can find that is living. Repeat the activity with the second transparency only trace and label everything they can find that is non-living.
2. After drawings are completed, have students answer the following questions.
   a. Looking only at the layer with living things, describe what relationships you can find among the organisms.
   b. How are the organisms helpful or harmful to one another?
   c. How would the removal of non-living factors in an ecosystem affect the survival of the living organisms?
   d. Looking only at the layer with non-living things, describe what relationships you can find among the parts.
   e. How would the removal of living organisms in an ecosystem affect the condition of the non-living factors?
   f. Combining both layers, what interactions/relationships can you find?
   g. What helpful or harmful effects do the living organisms have on the non-living factors?
   h. What helpful or harmful effects do the non-living factors have on the living organisms?

Alternatives:

- Fourth Grade use picture of Utah Wetlands for the activity
- Give all students the same picture or different pictures and discuss commonalities among different ecosystems
- Upper grades should define actual science terms such as Abiotic, Biotic, Symbiosis, etc. through additional activities or direct vocabulary instruction



Notes:

PREP: Minimal

TIME: 40-50 minutes

TYPE: Exploring/ Analyzing

Food Web Inquiry

Kit Materials:

- Picture Cards for each Ecosystem
- Expert Cards
- Question Cards

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

Biology Core
STANDARD I: Students will understand that living organisms interact with one another and their environment.

Objective 1: Summarize how energy flows through an ecosystem.
a. Arrange components of a food chain according to energy flow.
Objective 2: Explain relationships between matter cycles and organisms.
a. Use diagrams to trace the movement of matter through a cycle (i.e., carbon, oxygen, nitrogen, water) in a variety of biological communities and ecosystems.
b. Explain how water is a limiting factor in various ecosystems.
Objective 3: Describe how interactions among organisms and their environment help shape ecosystems.
a. Categorize relationships among living things according to predator-prey, competition, and symbiosis.
d. Investigate an ecosystem using methods of science to gather quantitative and qualitative data that describe the ecosystem in detail.

Overview:

Students will ask basic questions (how, why, what, where, when) about organisms and analyze them and how they relate to ecological issues.

Description:

Students will ask basic questions (how, why, what, where, when) about organisms and analyze them and how they relate to ecological issues. Because asking questions is an important aspect of thinking like a scientist, this activity is designed to get them to start thinking like biologists.

Activity #1—What's my organism? [10 minutes]

Each student chooses a picture card from one of the ecosystems. They should look at the organism, make sure they know what it is, and then keep it secret from the other students. If they don't know the organism they selected, they should consult the expert cards. Remind them to keep it hidden from other students.

Students will attempt to identify the secret organism of another student through a series of yes/no questions. Instruct students to record the following information in the appropriate place on their handout or in their journals: 1)the name of the other student, 2)what questions were asked, 3)how many questions it took to determine their organism, and 4)what was the most informative question they asked. One student should ask the other student about his/her secret organism; then they switch roles. If a student is asked a question to which s/he is unsure or does not know the answer, it is okay to say "I don't know" or "I think it is yes/no, but I'm not sure." Repeat the 20 Questions game one or two more times.

Question Card:

Document your answers to these questions and prepare to discuss them.

1. How could your organism and your partner's relate to one another?
2. What evidence is there to support your claim?
3. What factors do these organisms need to survive?
4. What ecosystem would provide those factors?
5. What advantages and disadvantages does this ecosystem provide?
   (It might help to gather data from other organisms in your ecosystem.)

Discussion and reflection on Activity #1 [10 minutes]

What questions were the most informative or helpful. Begin with questions you asked if need be. Write the student questions on the chalkboard as much as possible. Ask students if they can see any 'natural groupings' to the questions they identified (i.e. ways that some questions go together or variations on the same theme).

Allow them to discuss it with other students for a few minutes. Most of the questions that were asked can be divided into three categories:

- What does it look like? (Form: color, # limbs, hair, scales, etc.)
- What does it do? (Function: fly, swim, carnivore, dig, etc.)
- Where does it live? (Environment: land, water, Africa, forest, etc.)

Note: As much as possible, do not imply that there are only 'three' natural groupings.

(In fact, there are more. One example is: 'what is it classified as?', which forms a natural grouping of questions like 'is it a mammal?' or 'is it a fish?')

Activity #2 – How do I relate? [20 minutes]

Students will analyze their organism and other's to formulate relationships.

Alternatives/Suggestions/Extensions:

- Elementary-
  - Have a bag of plastic animals instead of just picture cards.
  - Place the students in their ecosystems before the activities.
  - Food Chain Practice
  - www.schools.utah.gov/curr/science/core/8thgrd/sciber8/bio_ener/html/chains.htm
- Secondary – Extension
  - Have the students correctly name and label each of the organisms in a given ecosystem. (Levels of Classification)

Resources/Websites

- Mountains Ecosystem:
  - Utah Division of Wildlife Resources, Learn about species: http://dwrcdc.nr.utah.gov/ucdc/default.asp
  - Snowbank Mushrooms: http://www.bridgerlandaudubon.org/wildaboututah/090505snowbankmushrooms.htm
  - Mold for Mountains Ecosystem: www.edupic.net/fungi.htm
- Rainforest Ecosystem
  - Fungus: http://rainforest-australia.com/fungi.htm
  - Rainforest Ecosystem pictures – just search for general items except the fungus.
- Marine/Ocean Ecosystem
  - Coralline Algae – Search Marine Coralline algae, pictures
  - Brown Diatom Algae – Search Marine Brown Diatom Algae, pictures
  - Bubble Coral & Coral Reef– Marine/Ocean Ecosystem: www.photovault.com/Link/Animals/Aquatic/kCoral/AAKVolume01.htm
  - Marine Worms – Ocean Ecosystem: Search Marine worm, pictures
- You'll need to choose 2

  Biomes

  Wetlands: http://fatfinch.files.wordpress.com/2008/08/wetlands.jpg

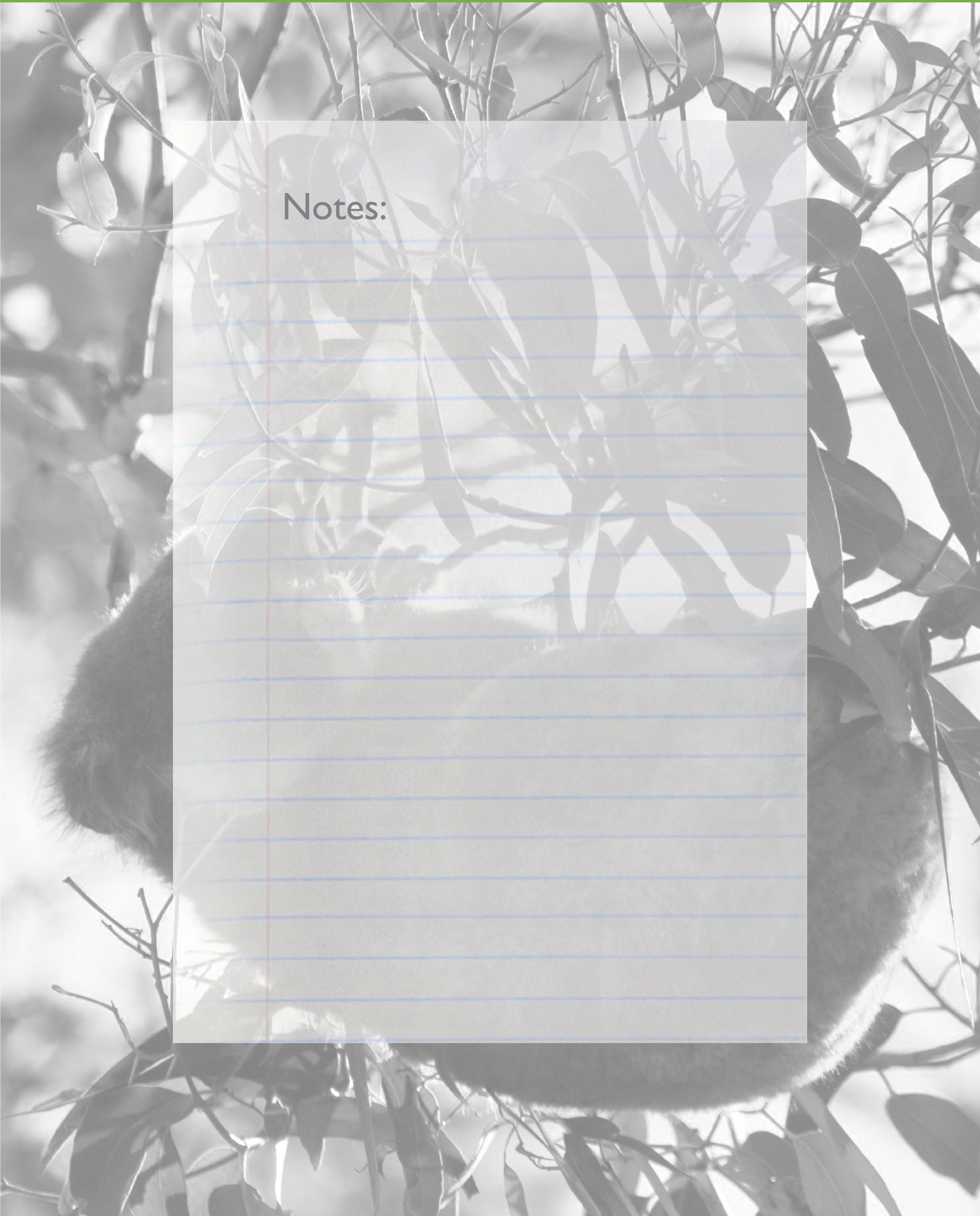
  Desert: http://www.rwongphoto.com/RW4245.html

  Forest: http://www.freewebs.com/icewarriors123/Rocky%20Forest%20Path.jpg

  Tundra: http://www.terragalleria.com/pictures-subjects/tundra/picture.tundra.romo0608.html

  Grasslands: http://www.terragalleria.com/pictures-subjects/grasslands/picture.grasslands.caab34006.html

  Marine: http://www.freewebs.com/jabukanews/ThunderballCave-underwater.jpg



Notes:

PREP: Room Setup

TIME: 40-50 minutes

TYPE: Exploring/ Analyzing

What's for Dinner?

Overview:
Students will identify and define trophic levels and symbiotic relationships.

Description:
Students will rotate through stations answering questions and defining core curriculum vocabulary based on their observations.

Station 1 Concept: Biotic/Abiotic
The samples are examples of biotic and abiotic components of an ecosystem. Based on your observations
1. Describe the characteristics you would use to group the samples into 2 categories.
2. What structural evidence supports your classification method?
3. How would you define Biotic and Abiotic?

(samples = rock, grass, small animal, soil)

Station 2 Concept: Predator/Prey
The specimens represent a predator and its prey. Based on your observations
1. What might each animal eat and be eaten by?
2. What characteristics affect the ability of the birds to eat specific types of food?
3. How does the ecosystem benefit from their relationship?
4. Define predator and prey

(hawk, finch)

Station 3 Concept: Competition
From the photos depicting populations of animals, make an inference about
1. What do the animals need to survive?
2. How does one animal's survival affect another member of the same group?
3. How might the size of the group affect their overall ability to survive?
4. Define competition and how it effects populations of organisms in nature.

(menu cards)

Station 4 Concept: Parasitism
These are all examples of parasites. Based on your observations
1. How might each of these organisms survive?
2. What is the affect of the parasite on its food source?
3. How is this different from a lion feeding on a zebra?
4. Define parasitism.

(menu cards)

Kit Materials:
Instructor Resources:
- Dinner Cards
- Specimens (choose specimens to match with the station concepts)
- Menu Cards

Classroom Transformation:
- Set up 9 stations with the specimens, menu cards and dinner cards.

Curriculum Connections:
ILO 1- ILO 4

SCIENCE

Biology Core

STANDARD I: Students will understand that living organisms interact with one another and their environment.

Objective 1: Summarize how energy flows through an ecosystem.

a. Arrange components of a food chain according to energy flow.

b. Compare the quantity of energy in the steps of an energy pyramid.

c. Relate reproductive isolation to speciation.

d. Compare the relative energy output expended by an organism in obtaining food to the energy gained from the food.

Objective 2: Explain relationships between matter cycles and organisms.

a. Use diagrams to trace the movement of matter through a cycle (i.e., carbon, oxygen, nitrogen, water) in a variety of biological communities and ecosystems.

Objective 3: Describe how interactions among organisms and their environment help shape ecosystems.

a. Categorize relationships among living things according to predator-prey, competition, and symbiosis.

Station 5 Concept: Mutualism

The relationship between these organisms represents mutualism. Based on your observations

1. What does each organism need to survive?
2. How does the relationship benefit or harm each organism?
3. Why do you believe these organisms are often found together?
4. Define Mutualism

(lichen, menu cards)

Station 6 Concept: Commensalism

The relationship between these organisms represents commensalism. Based on your observations

1. What does each organism need to survive?
2. How does the relationship benefit or harm each organism?
3. Why do you believe these organisms are often found together?
4. Define Commensalism

(menu cards)

Station 7 Concept: Producer

Each of these organisms is a producer. Based on your observations

1. What do these organisms need to survive?
2. How do these organisms obtain their food?
3. How are these organisms similar or different in different ecosystems?
4. Define producer

(menu cards)

Station 8 Concept: Primary and Secondary Consumers

The animals depicted are Primary or Secondary Consumers. Based on your observations

1. What does each animal eat?
2. How are their mouths/teeth different?
3. How does their food source obtain energy?
4. What role do plants play in each animal's food chain?
5. What is a Primary and Secondary Consumer?

(menu cards)

Station 9 Concept: Scavenger and Decomposer

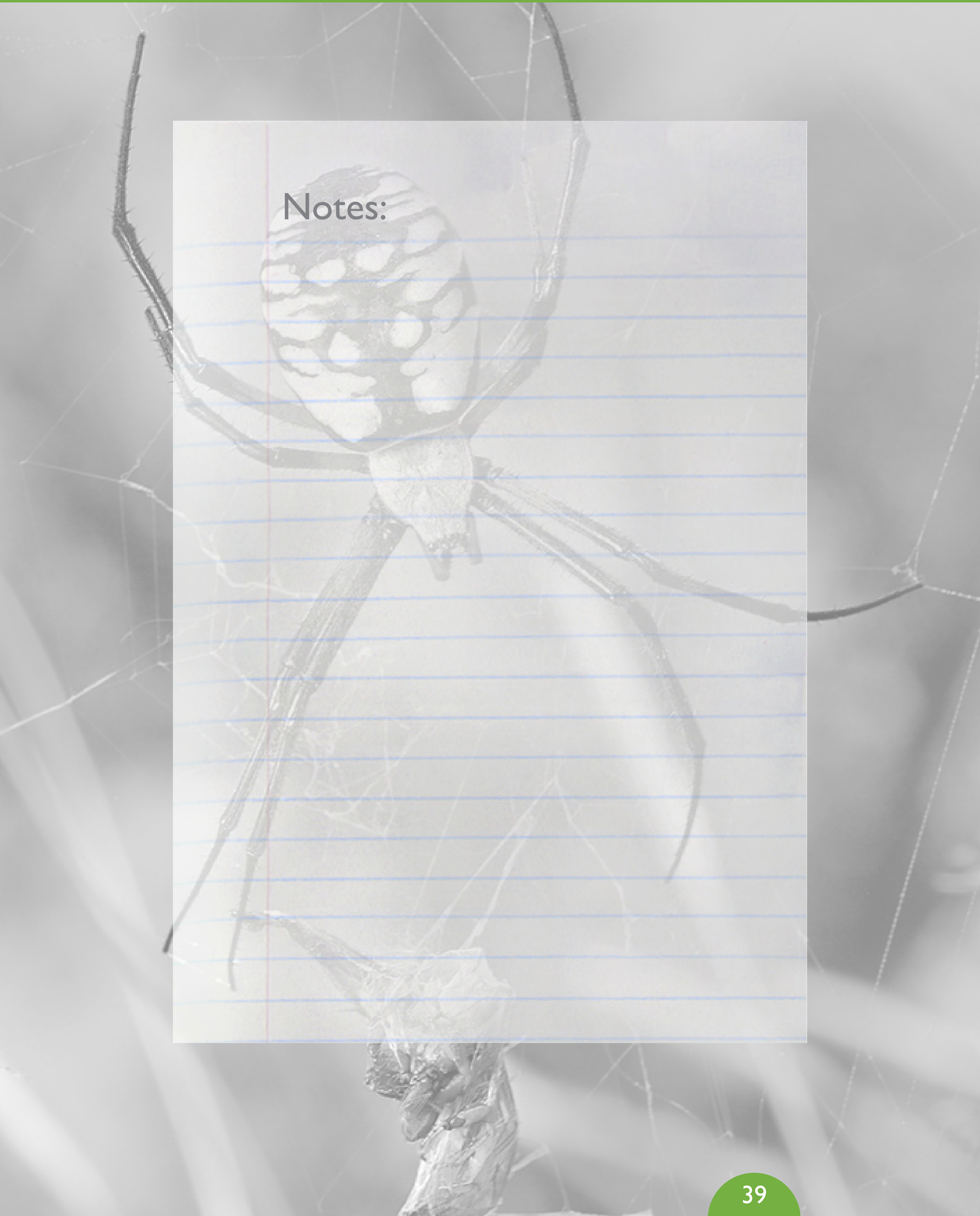
The specimens represent scavengers and decomposers. Based on your observations

1. What might each organism eat?
2. How would you group these organisms based on feeding practices?
3. How might these organisms be beneficial to their ecosystem
4. Differentiate between scavengers and decomposers

(menu cards)

Alternatives:

- Teacher should choose which question cards are appropriate based on grade level.



Notes:

PREP: Room Set-up

TIME: 20-40 Minutes

TYPE: Exploring/ Analyzing

Symbiosis

Kit Materials:

Instructor Resources:

• Symbiosis Cards

Classroom Transformation:

•Arrange the class into groups of 2 to 4 and divide the symbiosis cards equally among them

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

Biology Core
STANDARD I: Students will understand that living organisms interact with one another and their environment.

Objective 3: Describe how interactions among organisms and their environment help shape ecosystems.
a. Categorize relationships among living things according to predator-prey, competition, and symbiosis.
b. Formulate and test a hypothesis specific to the effect of changing one variable upon another in a small ecosystem.

Overview:

This activity will help students develop their understanding of the interconnectedness of organisms in an ecosystem. Specifically, students will identify relationships between species, the costs and benefits of the interactions, and learn how to test predictions about interspecific relationships.

Description:

Prior to this activity (maybe as homework), have the students read the paper titled "Red-billed oxpeckers: vampires or tickbirds?" by Paul Weeks found at http://beheco.oxfordjournals.org/cgi/reprint/11/2/154. This paper investigates the nature of the relationship between oxpeckers and ungulates and deomnstrates how gaining more information can change our understanding of relationships in nature as well as the importance of experiments. Have an in class discussion of the paper covering the following topics:

- Prior to this research, what did scientists believe about the relationship between oxpeckers and the host organisms (ungulates like cattle)? Why did they think this?
- How did Dr. Weeks test this idea? What were the results?
- Did his results change how scientists look at this relationship? If so, how?
- Why are experiments important in formulating ideas about relationships between species?
- What other experiments should be done about oxpeckers?

Using this information, demonstrate the activity with the "Oxpeckers and Ungulates" card. Go through the questions as explained in the "Instructions. Split the class into groups of 2 to 4 students with each group having the same number of images (two images each works well). The students then read the information on the front of the card and study the image. They are then asked to answer a few questions and predict what type of relationship this is (competition, predator-prey, mutualism, commensalism or parasitism). After answering these questions, they will flip the card over and read the additional information. Using this added information, they will answer more questions and devise an experiment to test their prediction.
After each group is finished with their questions, have each group give a short presentation to the class about their findings.

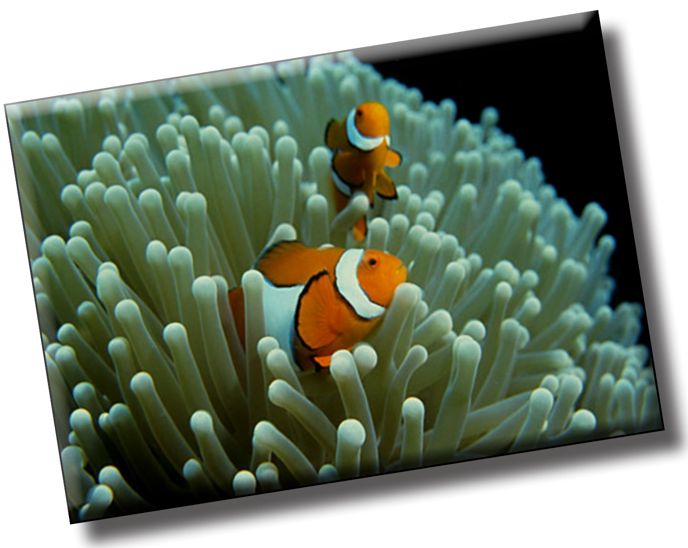
Alternatives:

Set up stations and have students rotate through each station, either in groups or as individuals. Perhaps select a handful of the images so students will have time to answer all the questions. After the students have rotated through all the stations, have a class discussion to go over their results.

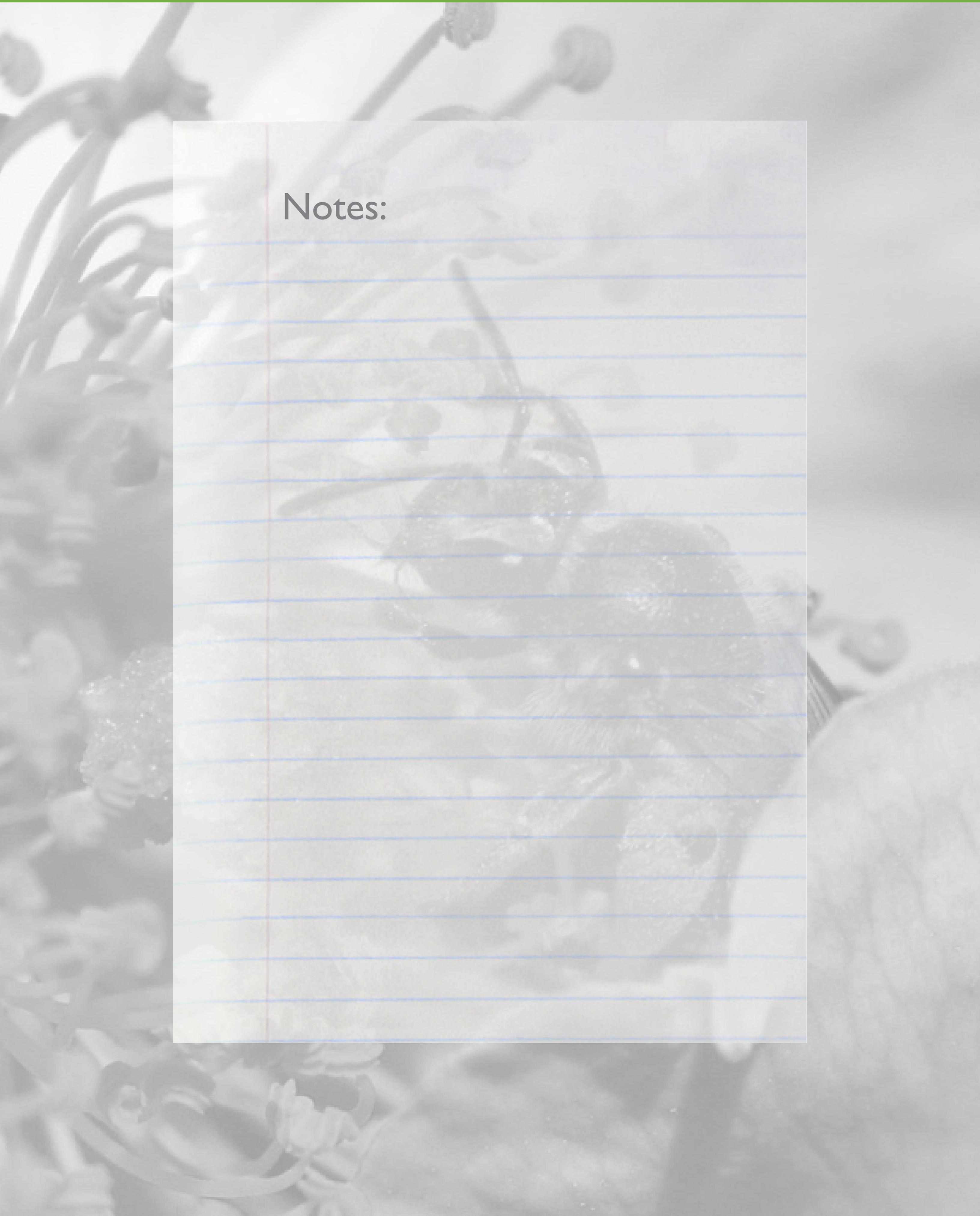
Instructions:

Study the image and the information about this relationship on the front of the card. Answer the following questions:

- What type of interaction does this appear to be? (The options are competition, predator-prey, mutualism, commensalism or parasitism.) What information would change our understanding of this relationship so that it would be classified as one of the other relationship types?
- Flip the card over and read the information on the back. With this new information, how would you classify this relationship? Design an experiment to test this.
- What is the benefit (if any) to the two organisms in this interaction? What is the cost of this relationship for each of these organisms? (What do these organisms have to give up to maintain this relationship?)



Notes:



PREP: Minimal

TIME: 70-90 minutes

TYPE: Exploring/ Analyzing

Crash

Overview:
By watching a video about the interaction between two species and answering questions, students will learn how delicate the balance is within an ecosystem and how humans can upset or restore this balance.

Description:
Watch Crash: A Tale of Two Species with your class. Have them answer the following questions in groups or by themselves.

Questions:
1. Describe the relationship between red knots and horseshoe crabs.
2. What biotic and abiotic factors can influence the red knot population? Include some factors that influence the horseshoe crab population as well as factors that influence red knots directly.
3. What steps were taken or are being taken to preserve the red knot population? For each step determine the impact it has on crab and red knot populations.
4. Black-footed ferrets rely solely on prairie dogs for food. They are now almost extinct because of the declining population of prairie dogs. Based on the information you gathered from the video on red knots and horseshoe crabs, come up with a plan of action for saving the black-footed ferrets.
5. Horseshoe crab eggs are used as food for red knots only once during the year, yet their abundance has a severe impact on red knot fitness. Can you think of other examples of organisms using one food source for only a short but crucial period of its life cycle? Examples can include:
    - Caterpillars relying on leaf matter until it turns into a moth or butterfly
    - Spring and summer booms in phytoplankton in warm waters allow temporary swells in marine life

Alternatives:
- Come up with additional questions for the class
- Have students research the topic and come up with questions for each other to answer.
- Hold an in class discussion covering these topics.
- Further research questions the claims in this video. Have students research futher discoveries and investigations. Have them determine what is solid fact and what might be inference in both the video and sources found in their research.

Kit Materials:
Instructor Resources:
- CRASH: A Tale of Two Species

Supplemental Materials:
- DVD player and projector

Curriculum Connections:
ILO 1- ILO 4

SCIENCE

Biology Core

STANDARD I: Students will understand that living organisms interact with one another and their environment.

Objective 1: Summarize how energy flows through an ecosystem.

a. Arrange components of a food chain according to energy flow.

c. Describe strategies used by organisms to balance the energy expended to obtain food to the energy gained from the food

d. Compare the relative energy output expended by an organism in obtaining food to the energy gained from the food.

e. Research food production in various parts of the world

Objective 2: Explain relationships between matter cycles and organisms.

c. Distinguish between inference and evidence in a newspaper, magazine, journal, or Internet article that addresses an issue related to human impact on cycles of matter in an ecosystem and determine the bias in the article.

d. Evaluate the impact of personal choices in relation to the cycling of matter within an ecosystem (e.g., impact of automobiles on the carbon cycle, impact on landfills of processed and packaged foods).

Objective 3: Describe how interactions among organisms and their environment help shape ecosystems.

a. Categorize relationships among living things according to predator-prey, competition, and symbiosis.

d. Investigate an ecosystem using methods of science to gather quantitative and qualitative data that describe the ecosystem in detail.

e. Research and evaluate local and global practices that affect ecosystems.

Notes:

PREP: Familiarity with Game

TIME: 50-90 Minutes

TYPE: Integration Activity

Succession Game

Overview:

This game teaches students about ecological succession. Using cards representing plants in different stages of succession, students will understand how primary succession occurs and the codependency of different organisms.

Game Rules:

Objective: In this game, each student receives a territory of 9 spaces. At the beginning of the game, the territory is solely occupied by rocks. The objective of the game is to slowly convert this territory to a climax forest. The first player with a forest (at least two climax trees) in their territory is the winner.

Objective: In this game, each student receives a territory of 9 spaces. At the beginning of the game, the territory is solely occupied by rocks. The objective of the game is to slowly convert this territory to a climax forest. The first player with two climax trees in their territory is the winner.

Cards:

Organism Cards:

- Plant Cards: The objective of placing plant cards in your territory is to gradually condition the land to help it develop into a climax forest. The steps of succession in nature correlate to the color of the cards in this game: white cards represent the first organisms found in a new habitat. Mosses (gray cards) come next followed by herbs (blue), shrubs (yellow), and finally trees (green). Plant cards affect all neighboring areas which share an edge with it. In order to play a card in an area, that area must have enough nutrients provided to it by neighboring plants so that the requirements on the card are met. The requirements are located in the top right hand corner of each card. The nutrients provided by neighboring cards are located in the description box on these cards.

- Orange and black cards: The cards in these groups form relationships with the plant cards. These classes of cards include Symbionts, Parasites, Seed Dispersal Agents, and Decomposers. These cards must have their nutrient requirements fulfilled through nutrient cards (see below for details) and not through nutrients provided by neighboring areas. Black cards are played to the side of the territory while orange cards are played in an area. Orange cards labeled "Symbiont" may share an area with a plant card. If you have a bird card and wish to hunt for worms on someone else's territory, pay 3 organic compound cards, roll the die and have your opponent roll the die. If you roll higher, remove the worm from your opponent's territory and take back your 3 organic compound cards. If your opponent rolls higher, the worm escapes and you do not recollect your organic compound cards.

Nutrient Cards: Some Organism cards provide extra nutrients when a certain number is rolled. All players with cards played that

Kit Materials:

Game Materials

9 game sets each containing a set of rules and 72 Succession Cards

Classroom Transformation:

- Set up playing areas for groups of 4 students

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE
Biology Core
STANDARD I
Objective 2: Explain relationships between matter cycles and organisms.
a: Use diagrams to trace the movement of matter through a cycle (i.e., carbon, oxygen, nitrogen, water) in a variety of biological communities and ecosystems.
b: Explain how water is a limiting factor in various ecosystems.
Objective 3: Describe how interactions among organisms and their environment help shape ecosystems.
a: Categorize relationships among living things according to predator-prey, competition, and symbiosis.
d: Investigate an ecosystem using methods of science to gather quantitative and qualitative data that describe the ecosystem in detail.

match the number shown on the die take the nutrient cards as directed by the plant cards. These nutrient cards may be used to supplement an area that does not quite meet the nutrient requirements of a plant. For example, if a card requires 4 minerals and the adjacent areas only provide 3 minerals to the area of choice, one mineral card may be played to meet the requirements. Nutrient cards may also be used to play non-plant cards. The nutrient requirements of the orange and black cards must be fulfilled through these nutrient cards and not from adjacent areas. When a nutrient card is used to fulfill the requirements of any card, that nutrient card is discarded.

Rolling:

Each turn a player rolls the die. If the number shown on the die matches with instructions on a plant card, take the nutrients as directed. These can be used to play orange and black cards or to make an area more fertile and meet the requirements of a plant card. For example, if you have a perennial grass card but an area is only provided with 3 minerals, you can use one of the mineral cards on this area to help meet the 4 mineral requirement of perennial grass.

Play:

Determine who goes first by rolling the die. The highest roller goes first. After their turn, play goes in a clockwise order.

Each turn:

- Roll the die. All players with plant cards matching the number shown take the nutrient cards as indicated by the plant card.
- Draw 4 Organism Cards off of the draw pile. If you held on to a card from the previous turn, add this card to the 4 you drew. These are the cards you may play this turn.
- Plant Cards: You may play any plant card on an area that matches or exceeds the nutrient requirements of that card. Nutrient cards may be used at this point to fulfill the requirements for a card. If no cards have been laid on your territory, you must first place a pioneer organism (cyanolichen or crustose lichen). After a pioneer organism has been placed, any card may be placed in an area that matches its nutrient requirements.
- Orange and black cards: These cards must have their nutrient requirements fulfilled through nutrient cards (see below for details) and not through nutrients provided by neighboring areas. Black cards are played to the side of the territory while orange cards are played in an area. If you have a bird card and wish to hunt for worms on someone else's territory, pay 3 organic compound cards, roll the die and have your opponent roll the die. If you roll higher, remove the worm from your opponent's territory and take back your 3 organic compound cards. If your opponent rolls higher, the worm escapes and you do not recollect your organic compound cards.
- If you do not use all of the Organism Cards you drew, you may hold on to any one card until next turn. All other Organism Cards must be discarded. (Hold on to nutrient cards until they are used.) Next turn you may use this card in addition to the four you draw. At the end of each turn, you may only have one Organism Card.

Questions:

After the students have finished playing the game, have each group discuss and answer these questions. After each group has had sufficient time, bring the class together and have a class discussion using these questions as a guide.

- What is the role of a pioneer organism?
- What is ecological succession? Why does it occur? What factors prevent a climax tree from colonizing a previously uninhabited area? What does a tree require to survive?
- What is the role of non-plant organisms in succession?
- If the original territory is in a dry climate, how does water play a role in succession? How does each step in succession increase water availability for organisms?
- What do you think the steps of succession in an aquatic environment would be?

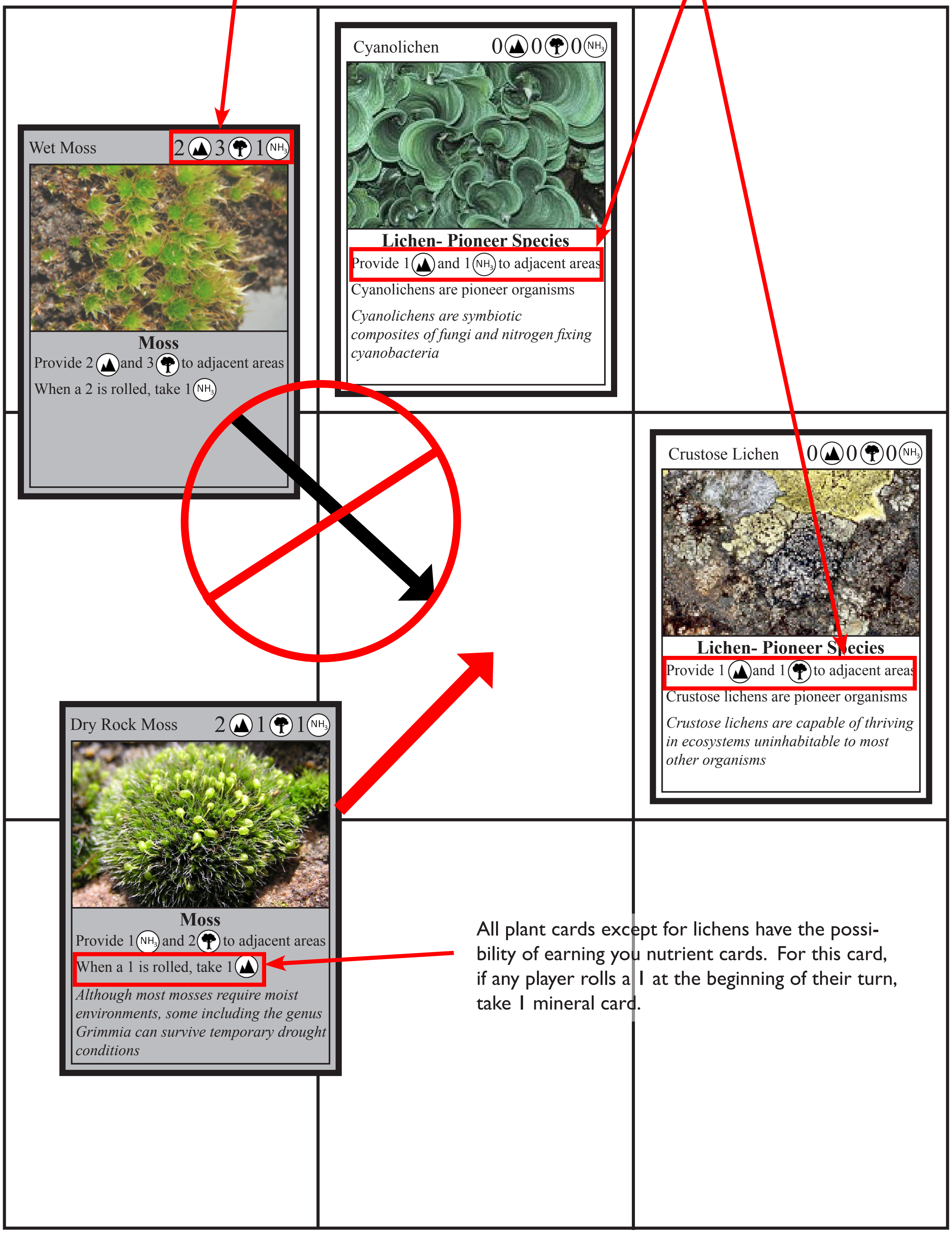
Alternatives:

- Watch the selection of Planet Earth: Jungles focusing on Succession in addition or preparation for this game.

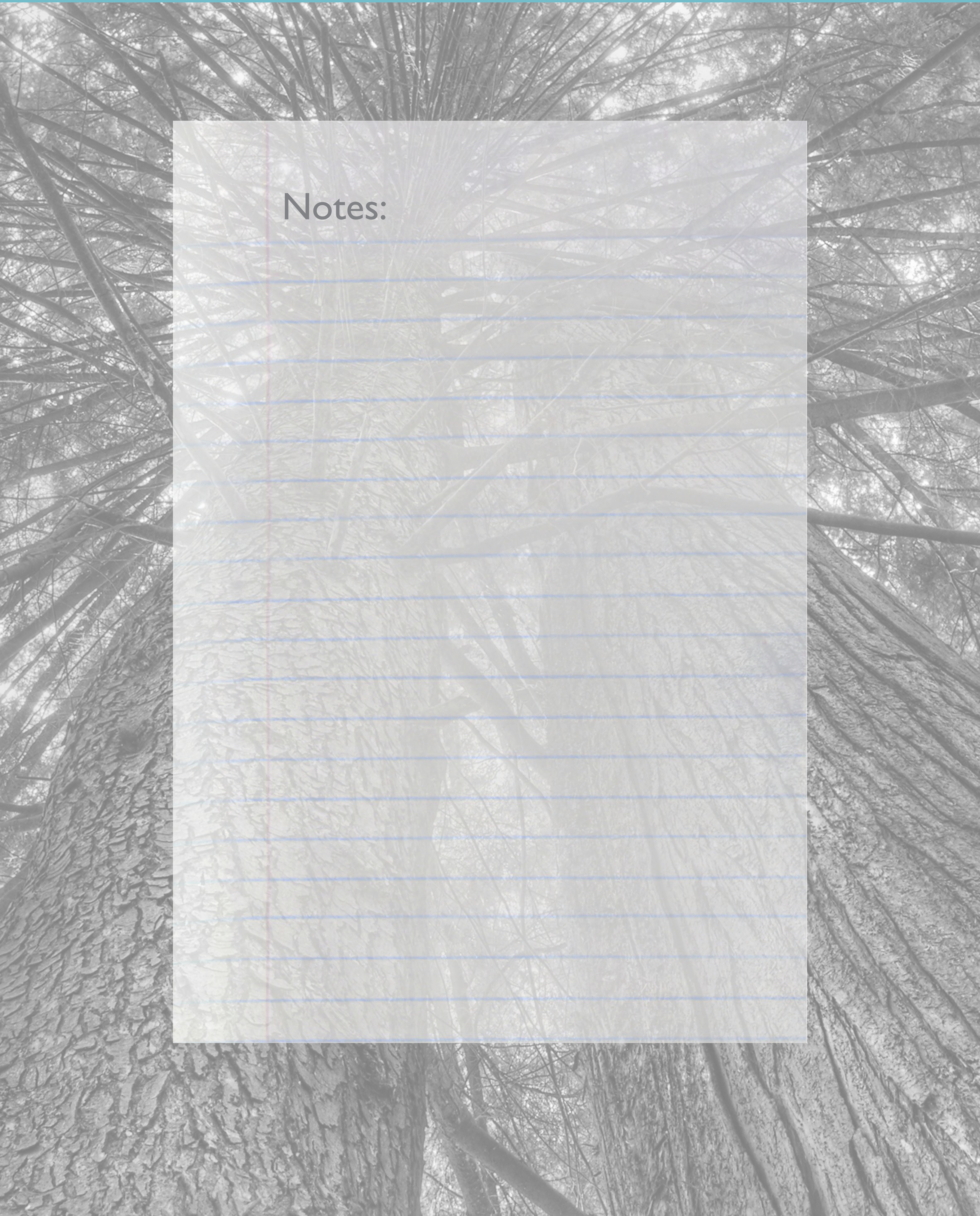
In this situation where the cyanolichen and the crustose lichen cards are down, the middle area is conditioned to the point where a Dry Rock Moss card can be played. Notice that the combined nutrients supplied by the cyanolichen and crustose lichen to the middle area equals the requirements for the Dry Rock Moss. However, the Wet Moss requirements are not yet met so it cannot be played.

This box represents the nutrient requirements that must be met by adjacent areas and nutrient cards before this card can be played.

These boxes represents the amount of nutrients supplied by this card to adjacent areas, making the neighboring areas more habitable.



All plant cards except for lichens have the possibility of earning you nutrient cards. For this card, if any player rolls a 1 at the beginning of their turn, take 1 mineral card.



Notes:

PREP: Familiarity with Game

TIME: 1 Class Period

TYPE: Integration Activity

Coevolution

Overview:

In this game, students will learn about coevolution of species. Students will simulate predator-prey interactions and observing the progressive change in traits over time as a direct consequence of the interaction.

Description:

This game is designed for sets of 4 students.

Set up:

Lay the board (ignore the writing which is intended for The Hunt activity) and the two adaptation wheels down on the playing surface. Shuffle all the prairie dog cards (120 cards per group) together in one pile and all the ferret cards (60 cards per group) together in another. The players roll the dice. The two players with the highest rolls play as ferrets and the other two players play as prairie dogs. Each ferret player draws 10 ferret cards and each prairie dog player draws 30 prairie dog cards. Notice that each card has two numbers on it: a speed number and an adaptation number. The speed number relates to how likely it is that the prairie dog will escape and the adaptation number relates to the adaptation wheel. Before beginning play, each player finds the average speed number of their cards and writes it down at the top of the fixed traits card. One of the ferret players spins the ferret adaptation wheel and one of the prairie dog players spins the prairie dog adaptation wheel. Each adaptation will be matched with an adaptation number, and all animals obtain the adaptation matching their adaptation number. Some adaptations will help the animal survive, some are neutral, and some are maladaptive (harmful).

Once the adaptations have been assigned, the prairie dog players place their pieces on the game board. Players should pay attention to which color adaptation appears the most among prairie dogs. It is smart for prairie dog players to place their token on the territory with matching background color. Prairie dog colonies cannot share territories. Once the prairie dog territories have been claimed, ferret players place their tokens in the same territory as a prairie dog colony.

Play:

Once territories have been established and the wheels have been spun, ferret players line up their cards in random order face down so the prairie dog player can't see. The prairie dog players shuffle their cards and line them up with the ferret cards of the player in the same territory. Each prairie dog needs to be lined up with a ferret and the number of prairie dogs per ferret should be as evenly divided as possible. On the first turn, there will be three prairie dog cards lined up with each ferret card. Once all the cards have been laid down, flip

Kit Materials:

Game Materials:

9 Game Boards from The Hunt game set
9 game sets each containing a set of rules and:

- 1 Ferret Adaptation Wheel
- 1 Prairie Dog Adaptation Wheel
- 120 Prairie Dog Cards
- 60 Ferret Cards
- 2 Ferret Pieces
- 2 Prairie Dog Pieces

Classroom Transformation:

- Set up playing areas for groups of 4 students

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.
Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a: Predict why certain traits are more likely to offer an advantage for survival of an organism.
b: Cite examples of traits that provide an advantage for survival in one environment but not other environments.
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

Biology Core

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes
Objective 1: Relate principles of evolution to biological diversity.
a: Describe the effects of environmental factors on natural selection.
b: Relate genetic variability to a species' potential for adaptation to a changing environment.
Objective 2: Cite evidence for changes in populations over time and use concepts of evolution to explain these changes.
b: Identify the role of mutation and recombination in evolution.

them over. Add together the speed number with the adaptation benefits for each card. For example, if a prairie dog card has a speed of 5 and has the adaptation "Ability to Stand", add 2 to the speed to get an escape number of 7. The card with the lowest final escape number in each group is the one selected by the ferret to hunt. Both players roll one die, repeating the roll if both roll the same number. The player with the higher number adds one to the hunt or escape number of their animal. The animal with the higher total hunt/escape number survives (return the card to the group) and the other animal dies (discard this card). Follow these instructions for all 10 groups. Once all players have finished this round, each player reshuffles their surviving cards together and repeat this procedure, but do not change the adaptation wheels. However, there are no longer 10 ferrets and 30 prairie dogs. Line up the ferrets and divide the prairie dog cards as evenly as possible among the ferret cards. For example, if there are 7 ferrets left and 23 prairie dogs, there will be 5 groups of 3 prairie dogs per ferret and 2 groups of 4.

After two rounds, find the average speed of your surviving animals. The animals reproduce, replenishing the stocks to the original number, 30 for prairie dogs and 10 for ferrets. Look through the decks and take the required number of cards, making sure that the average speed of these cards is close to, but not more than, the average speed of the surviving animals. Additionally, take note of which adaptation from the previous round has survived in the greatest frequency. This trait goes to fixation for the next round, meaning that all members of this colony have this trait. For example, if 15 prairie dogs survived two rounds and 4 of those prairie dogs had the adaptation of black eyebrows and no other adaptation had more than 2, all prairie dogs in this colony from now on have black eyebrows. Write this down on the "Fixed Traits" card. Now that the populations have been replenished, spin the adaptation wheels again for new traits. The traits of each animal include all the fixed traits plus the new trait on the adaptation wheel. However, any animal that has an adaptation number matching the fixed trait has no change. Complete two rounds of hunting and once again make note of the average speed, determine which trait goes to fixation, and replenish the population back to original numbers. Repeat this procedure 5 times.

After 5 cycles, each player determines the final speed number and adds to that the adaptation benefits that have gone to fixation to determine their average escape or hunting number. The prairie dog player in the class with the highest escape number and the ferret player with the highest hunting number are the winners.

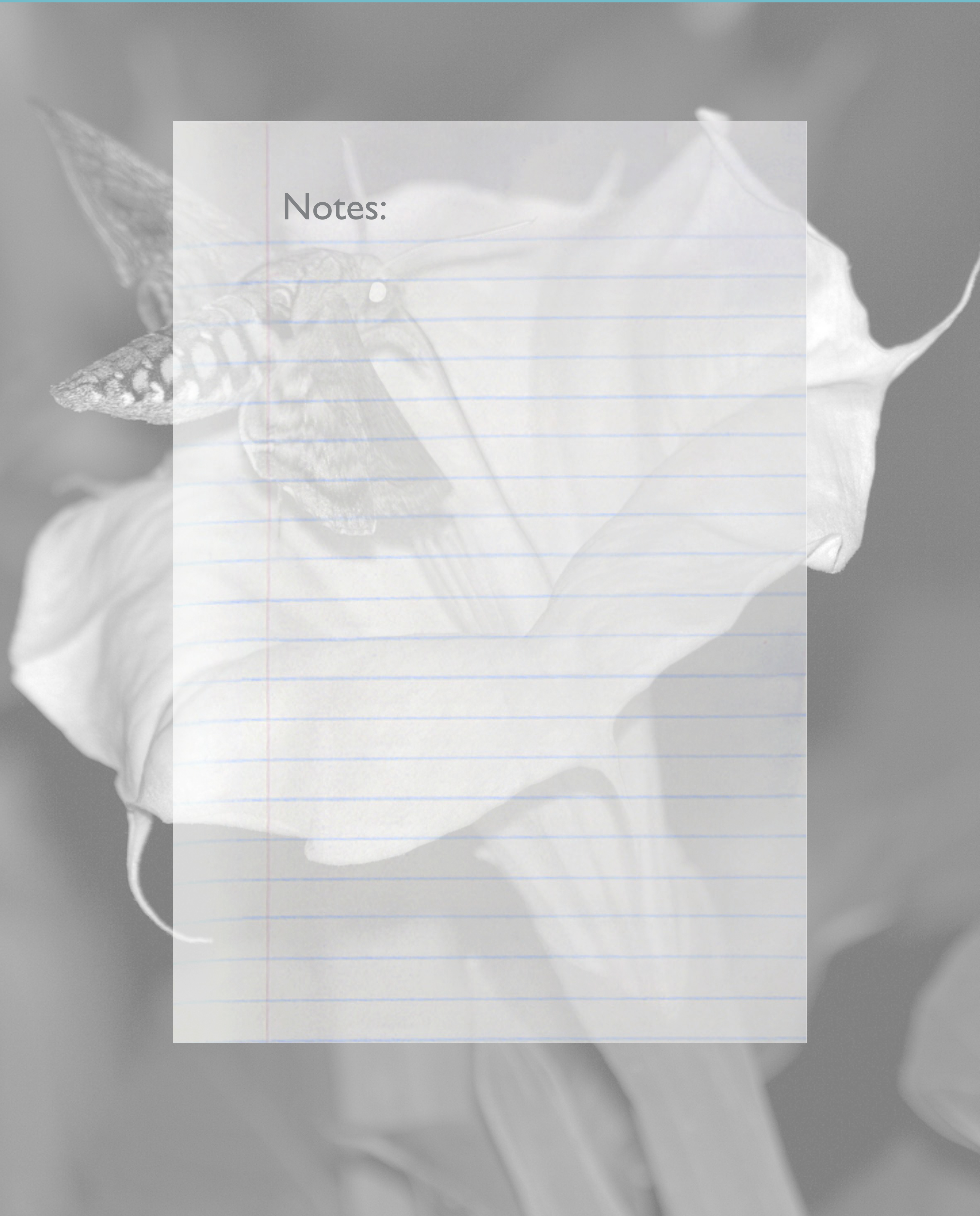
Alternatives:

- A simpler form of the game can be found at http://findarticles.com/p/articles/mi_6958/is_4_69/ai_n28537421/
- Have the students research coevolution as well as evolutionary arms race. After doing some research, have the students answer the questions associated with this activity.

Questions:

1. How does the evolution of a pedator impact the prey? vice versa?
2. Often, as in this game, the weakest, slowest, or sickest of a herd is selected by the predator to minimize energy expenditure. What impact does this have on the prey herd?
3. In what ways does the interaction between pollinators and flowering plants an example of coevolution?
4. Can you think of other examples of coevolution?
5. Some forms of coevolution can be compared to an arms race, similar to the nuclear armament escalation which ocurred during the cold war. In this case, both sides continually built their nuclear weapon stash trying to get ahead of the other but with no real progress made. Every advancement on one side was met with an advancement on the other. How is coevolution similar to such an arms race?
6. Define coevolution. After coming up with your definition, gather in a small group to compare definitions. Compile your answers to form a more comprehensive definition. Hold a class discussion and gather all the ideas and determine the definition of coevolution as a class.

Notes:



PREP: Familiarity with Game

TIME: 1 Class Period

TYPE: Integration Activity

The Hunt

Overview:

This game is designed to teach students about energy considerations in the wild. Animals must obtain more energy from food than they expend obtaining it. Students will play as ferrets and try to maximize the energy obtained while minimizing the energy lost during the hunt.

Description:

Up to four players can play. Each player rolls the dice to see who goes first. The highest roller gets to choose where to put their ferret on the board (territory 4 is the most fruitful). The selection then goes to the next player in a clockwise manner.

Once all ferrets have been placed, place 20 of the appropriate prairie dog tokens in the territories. Place the season card so that Spring/Summer is face up. The player with the highest roll then begins his turn.

Play:

On each turn, the player must:

- Pay one energy point
- Spin the dial and follow the instructions
    - **+1, +2, +3:** Add the number of prairie dogs to your territory
    - **Plague:** half of the prairie dogs in your territory die. Remove them from your territory
    - **Winter:** When this is rolled, turn the season card so that winter is face up. In territories 1, 2, and 3, no hunting can be done in the winter. Ferrets in these territories still pay one energy token per turn unless you choose to hibernate. (See hibernation). Winter lasts until Spring or Summer is spun.
    - **Spring or Summer:** If the season is winter prior to the spin, landing on this space ends winter and hunting is possible again. Flip the season card to Spring/Summer. If it is not winter, nothing happens
    - **Windy:** If it is windy, the prairie dogs can't communicate as effectively, allowing for easier hunting. Subtract one from the prairie dog roll this turn.
    - **Calm:** Prairie Dogs can communicate easier, making it harder to hunt. Add one to the prairie dog roll this turn.

Kit Materials:

Game Materials:

9 game sets each containing a set of rules and:

- 1 game board
- 4 Ferret Tokens
- 120 Prairie Dog Tokens
- 1 Season Card
- Energy Point Cards

Classroom Transformation:

- Set up playing areas for groups of 4 students

Specimens:

- None

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

Biology Core

STANDARD I

Objective 1: Explain relationships between matter cycles and organisms.

c: Describe strategies used by organisms to balance the energy expended to obtain food to the energy gained from the food (e.g., migration to areas of seasonal abundance, switching type of prey based upon availability, hibernation or dormancy).

d: Compare the relative energy output expended by an organism in obtaining food to the energy gained from the food (e.g., hummingbird - energy expended hovering at a flower compared to the amount of energy gained from the nectar, coyote - chasing mice to the energy gained from catching one, energy expended in migration of birds to a location with seasonal abundance compared to energy gained by staying in a cold climate with limited food).

Objective 3: Describe how interactions among organisms and their environment help shape ecosystems.

a: Categorize relationships among living things according to predator-prey, competition, and symbiosis.

c: Use data to interpret interactions among biotic and abiotic factors (e.g., pH, temperature, precipitation, populations, diversity) within an ecosystem.

e: Research and evaluate local and global practices that affect ecosystems.

The Hunt

... Continued

On each turn, you may do one (but only one) of the following:

- Hunt: on each turn (that is not winter if you are in territories 1, 2, or 3) you can choose to hunt, provided that there is at least 1 prairie dog in the territory. Pay one energy token for the opportunity to hunt, if you choose to do so. The person to your left, acting for the prey, rolls a die numbered 1 through 3. Add the defense number (which is located on the board in your territory) to the roll. The defense numbers are as follows:

    - Territory 1: 0
    - Territory 2: 1
    - Territory 3: 2
    - Territory 4: 2 in winter, 3 at all other times

  After determining the Prairie Dog defense, it is your turn to roll. If your roll is higher than the Prairie Dog total roll, then you catch one prairie dog and take one prairie dog token from your territory. If your roll equals the defense, it means there is a struggle to catch the prairie dog. Pay one more energy point (reflecting the increased energy expense to catch the prey), and take one prairie dog from your territory. If you choose to eat your prey, take the corresponding energy points (3,4,5, or 6 for territories 1,2,3, and 4 respectively) and discard the prairie dog token. Alternatively you can store this for later. At any point, a ferret can have a max of 25 energy points, so if consuming a prey would put you over 25, you might consider storing it until you can make full use of it later. Be careful because if anyone challenges you for your territory, stored food stays in the territory.
- Fight for a Territory: If a player has a territory that you want, you can challenge that player. Pay two energy points. Indicate which territory you want to fight for. The defender of that territory must pay one energy point. The attacker rolls one die and the defender rolls two dice. The person with the highest die wins, or if there is a tie, the dice are rerolled until there is a winner. If the defender has the highest roll, nothing changes. If the attacker wins, the defender must move to a vacant territory, leaving any stored prey in the hands of the victor. Once a particular territory has been challenged, no one else can challenge until the attacker has gone again. For example, if player one fights for territory 3, there can be no more challenges to territory 3 until all 4 more turns have gone by and it becomes player 2's turn, although other territories can be challenged during that time.
- Migration: If there are less than four players, there will be at least one empty territory. Players can migrate to an empty territory at no cost.
- Hibernation: Every turn costs 1 energy point, except during hibernation, where you pay 2 to hibernate 4 turns. This can be beneficial during the onset of winter.

  Energy points: a ferret needs energy to survive, but it can't store excessive amounts of energy as fat without having negative effects. The maximum level of energy a ferret can have in this game is 25 energy points. That is why storing caught prey is important. If a ferret is at 24 energy and catches a prairie dog, the player can choose to eat the prey to bring the energy up to 25 and discard the remaining energy or the player can save the prey for use on a later turn.

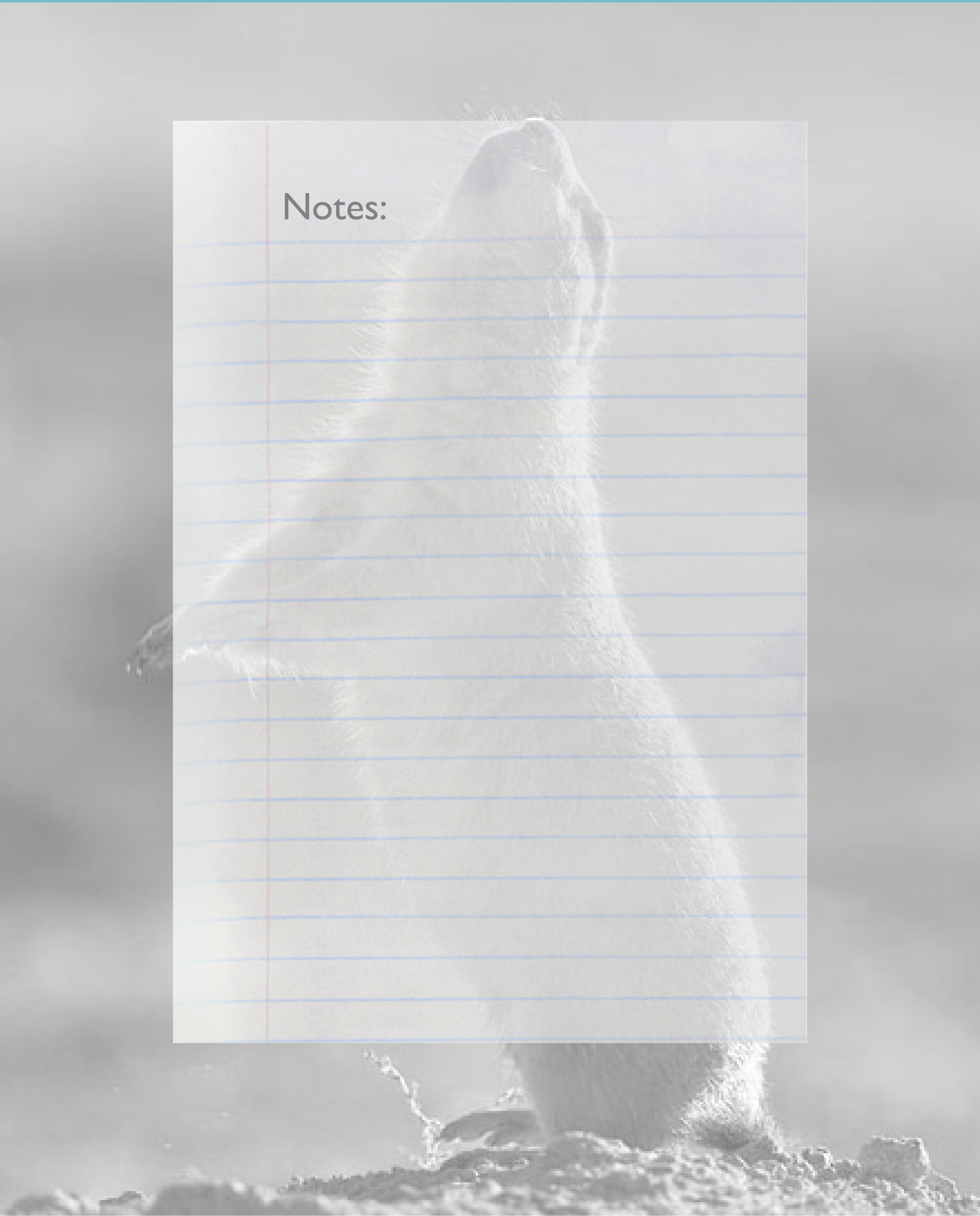
  If a player runs out of energy points, the player is skipped for two turns, at which time they take 5 energy points and continue.

End of Game:

The game is designed to continue until the teacher closes the game for the class. This can be based on a set amount of time. The suggested length of time for the game is 45 minutes, but the teacher can make adjustments as necessary.

Questions:

1. This activity should have taught you that there is no such thing as a free lunch. In order to acquire food or other sources of energy, an organism must expend a certain amount of energy. For each of the following organisms, determine where energy is expended in order to acquire more energy.
    - Human
    - Wolf
    - Hummingbird
    - Blue Whale
    - Polar Bear
    - Cattle
    - Redwood Tree
    - Mosquito
    - Bacteria
2. List all the ways you can think of that organisms minimize their energy expenditure to acquire food, both ways included and not included in the game. These methods should include but not be limited to hunting strategies, seasonal behaviors, and relationships with other organisms. The following animals should give you a headstart in dealing with the methods above: spiders, bears, and hyenas.
3. Describe how each of the methods you described for question 2 save the organism energy.
4. What abiotic factors require organisms to expend greater amounts of energy to acquire more food? biotic factors?



Notes:

PREP:
Familiarity
with Activity

TIME:
1 Class
Period

TYPE:
Integration
Activity

Speciation

Overview:

This activity is a simulation of speciation to help students understand how evolution created the extraordinary biodiversity of this world. Students will follow a population of flies through the evolutionary process as it colonizes a new ecosystem.

Description:

Have the students read the pages entitled "New Ecosystem Colonization" followed by the article "An Adaptive Radiation has led to a Dramatic Diversification of the Drosophilids in Hawaii." Have a class discussion about the contents including genetic drift, natural selection, and bottlenecks like the founder effect. At this point separate the class into groups (groups of four work well) and pass out and explain the rules to the class. Have them follow the rules and begin the simulation.

Rules:

You and your group get to go on a vacation to Hawaii! The one downside; you will be turned into a population of flies. The diversity of flies in Hawaii is amazing and acting as a population of flies will help you to understand why. A new island has formed and it has been colonized by plants, but there are no other insects there yet. Your group has migrated to this island and you will be responsible for the evolution of your population on this island.

This simulation is separated into four phases: the Founder Event, Drift Phase, Adaptive Radiation Phase, and Selection Phase. Groups of four will work together to determine the evolutionary process for one population. After the simulation, compare results to determine the degree of separation from the initial population.

Read the pages entitled "New Ecosystem Colonization" followed by the article "An Adaptive Radiation has led to a Dramatic Diversification of the Drosophilids in Hawaii." After gaining a basic understanding of the principles guiding evolution in a new ecosystem, use the following steps for your simulation.

Founder Event: Each group draws two Founder Cards representing organisms from the mainland population. These two organisms are blown from the original island to an uninhabited island. They are the founders of the population on the new island. Each card has the genotype of the organism it represents. Because these two genomes are much less diverse than the entirety of the original population, already this new population is different.

Kit Materials:

Instructor Resources:

1 Sheet of Offspring Cards
1 copy of "New Ecosystem Colonization"
1 Copy of "An Adaptive Radiation has led to a Dramatic Diversification of the Drosophilids in Hawaii"

9 game sets each containing a set of rules and:
- 1 Mutation Wheel
- 42 Founder Cards
- 1 Genotype Card
- 1 Punnet Square Cards

Classroom Transformation:

- Set up playing areas for groups of 4 students. Make 2 copies of the Offspring Cards per group and 1 copy of New Ecosystem Colonization and the article per student.

Curriculum Connections:

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.
Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a: Predict why certain traits are more likely to offer an advantage for survival of an organism.
b: Cite examples of traits that provide an advantage for survival in one environment but not other environments.
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

Biology Core

STANDARD IV: Students will understand that genetic information coded in DNA is passed from parents to offspring by sexual and asexual reproduction.
Objective 1: Compare sexual and asexual reproduction.
b: Compare the advantages/disadvantages of sexual and asexual reproduction to survival of species.
STANDARD V: Students will understand that biological diversity is a result of evolutionary processes
Objective 1: Relate principles of evolution to biological diversity.
a: Describe the effects of environmental factors on natural selection.
b: Relate genetic variability to a species' potential for adaptation to a changing environment.
c: Relate reproductive isolation to speciation.

Speciation

... Continued

There are 6 genes listed per genotype and each gene is directly responsible for specific traits. The following chart shows the effect different alleles of these genes have as well as the frequency of the alleles in the mainland population.

Gene	Alleles	Allele frequency in Mainland Flies
A, determines size	"A" makes a fly large, "a" makes a fly small	50% A, 50% a
B, determines mating season	"B" makes a fly mate in summer, "b" makes a fly mate in fall	60% B, 40% b
C, wing structure	"C" makes the wings normal, "c" gives the fly an extra pair of wings	80% C, 20% c
D, Hair	"D" makes a fly hairy, "d" makes a fly hairless	50% D, 50% d
E, Eye color	"E" makes the eyes red, "e" makes the eyes yellow	70% E, 30% e
F, Food preference	"F" makes the fly prefer fruit, "f" makes the fly prefer nectar	50% F, 50% f

Drift Phase: After a founder event, the population size of the island is very small (initially 2). Because of the small number, small random events such as meiosis can have a huge impact on the allele frequency of the population. When the population is small, genetic drift is the primary evolutionary driving force. You will simulate genetic drift with Punnett Squares. Line up the genotype of each of the parents (found on the Founder Cards) on the Punnett square. Roll the four-sided dice six times, once per gene, to determine the genotype of one member of the first generation (F1) and write it down on a separate piece of paper. Using the same Punnett squares, roll the dice again to determine the genotype of the second member of the F1. These will be the parents of the next generation. Line up their genotypes on the Punnett square and roll the dice to determine two members of the F2 genotype. Finally, use the F2 genotypes on the Punnett square and roll to determine two F3 genotypes. This will be the base genotype during the Adaptive Radiation Phase. Any gene that is homozygous in both members of the F3 is considered to be fixed. At this point groups can compare their populations. Because of different mating seasons, sizes, and appearances due to genetic drift, organisms in these populations will not be compatible mates and become distinct species from one another.

Adaptive Radiation Phase: Because the island was previously unpopulated, there are several unfilled niches. There are no other organisms to compete with, allowing virtually every fly offspring to survive, essentially removing the role of natural selection. Until the flies become numerous enough to compete with each other for resources, mutations can accumulate with little harmful effect. You will simulate fly reproduction using offspring cards and the mutation wheel. There will be three rounds of reproduction resulting in the accumulation of many mutations. Line up 8 offspring cards. Leave four blank and on the other four write down a number between 1 and 8, selected as randomly as possible. Spin the mutation wheel to determine which mutations these four offspring receive. Mark on the cards the mutation coordinating with their numbers. For the next round, shuffle these 8 cards together and lay them out in 4 pairs. Place four new cards under each pair for a total of 16 cards. These represent the next generation. Mark down on these cards the mutations of the parents. For each set of four, write a random number between 1 and 8 in the mutation # box on 2 cards. Spin the wheel to determine the mutations of this generation. Once the mutations have been marked, shuffle the cards for this generation together and lay them down in 8 pairs. Once again lay down four new offspring cards per pair and write mutation numbers for 2 of these. Spin the wheel one last time and determine the mutations of this group. Discard all the cards from previous generations.

Selection Phase: Once the island reaches a critical population, the island becomes crowded enough that competition for resources becomes an issue. During this process, the flies that are best adapted to their niches survive at higher rates. You will determine the 5 fittest flies for each of three niches. One niche is consuming decomposing plant matter. In this simulation, this will be called the beetle niche. The adaptations for this niche are heavy jaws and being flightless. Flightlessness is not an advantage for this niche unless the insect already has the adaptation for heavy jaws. Another niche is the fly niche. Most of the flies are already adapted to this, but a series of adaptations can increase their fitness. Male flies fight over females and the victor mates with the female. Flies more likely to win a fight will have more offspring. On some islands flies have evolved new fighting styles. The traditional style involves grappling. A new style that has evolved is head-butting. To accommodate this, evolving larger heads with eyes set back provide greater fitness in this style of fighting. Without the behavioral adaptation to this fighting style, these other adaptations are not beneficial. The last niche is the predatory niche. Predatory insects have enzymes that paralyze their prey and begin to digest their insides. They have a strong proboscis or feeding tube which is used to suck out the insides of their prey.

To determine which flies survive, look first for the adaptations in bold on the offspring cards. These are critical for the beetle and fly niches and other adaptations are useless without these. Aside from the adaptations in bold, look for which niche a fly has the most adaptations and place the flies in the appropriate niche. After the flies have been separated into their best niche, select the 5 fittest flies in each niche and discard all others. Use the values in the following chart to calculate fitness. Start with a fitness of 1 and add or subtract the values according to the following chart.

Head-butting	No change to fitness by itself
Enlarged head	With head-butting, adds .3 to fitness in the fly niche. Without head-butting or in another niche, subtracts .1 from fitness.
Eyes back	With head-butting, adds .2 to fitness in the fly niche. Without head-butting or in another niche, subtracts .1 from fitness.
Heavy Jaws	With flightlessness, adds .3 to fitness in the beetle niche . Without flightlessness or in another niche, subtracts .2 from fitness.
Flightless	With heavy jaws, adds .2 to fitness in the beetle niche. Without heavy jaws or in another niche, subtracts .5 from fitness.
Paralytic Enzymes	Adds .3 to fitness in predator niche. Subtracts .2 from fitness in all other niches.
Strong Proboscis	Adds .4 to fitness in predator niche. Subtracts .2 from fitness in all other niches.
Camouflage	Adds .2 to fitness in all niches.

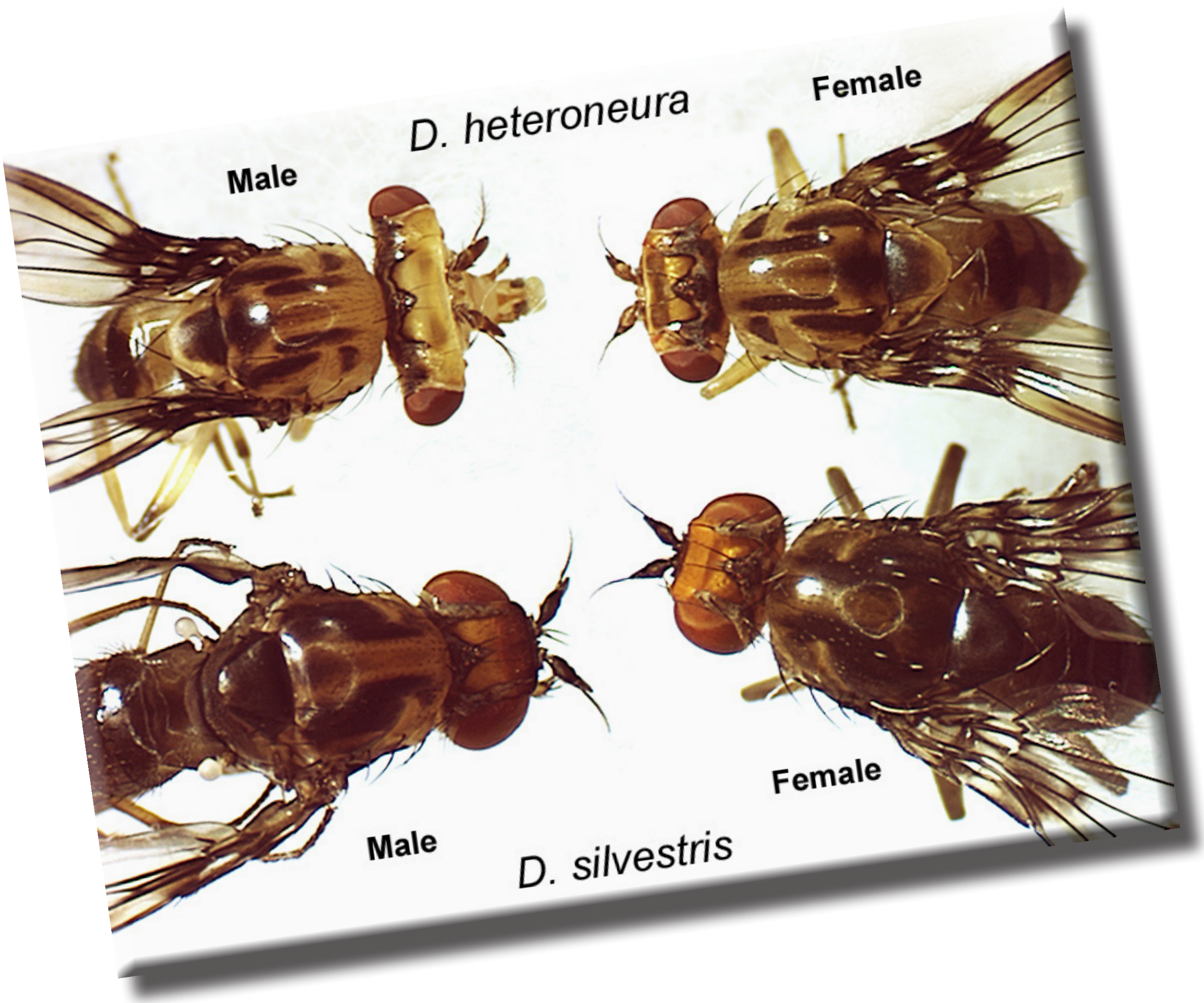
Speciation

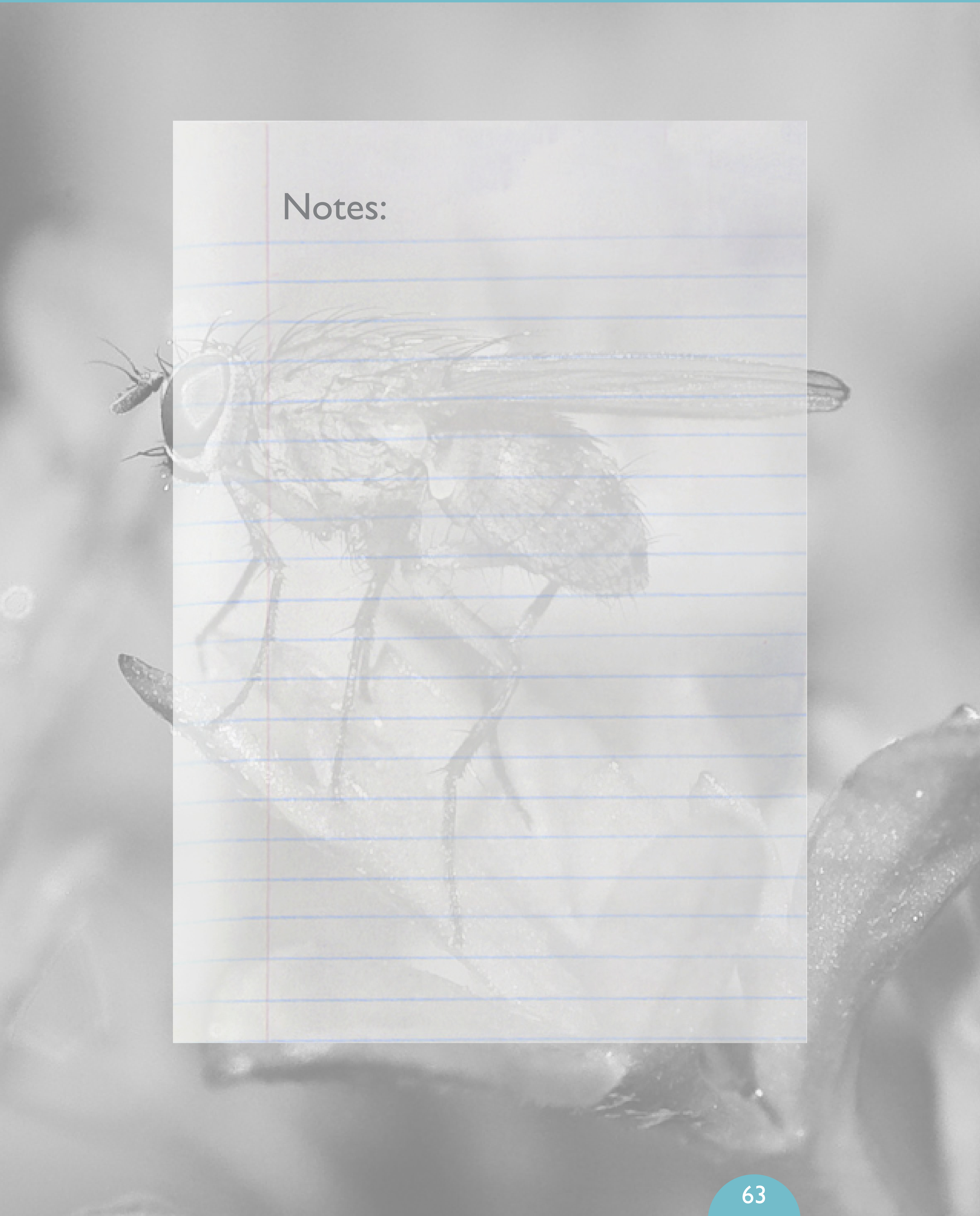
... Continued

After the 5 fittest flies in each niche have been selected, all groups compare the results of their evolution. Compare the genotypes that evolved through genetic drift and compare the results of selection. (You should see that genetic drift is random and causes diversions, but selection should be convergent.)

Questions

1. What are the problems with this simulation? In what ways is this simulation inaccurate and in what ways is it accurate?
2. How would this simulation differ for organisms that reproduce asexually? for organisms that can reproduce both sexually and asexually?
3. What other founder events can you think of? How would these change the outcome of this simulation?
4. What would happen if the drift phase lasted longer?
5. How would this simulation differ if there were beetles filling that niche when the flies migrated to the island?
6. How does speciation on an island as outlined by this simulation differ from evolution on the mainland?
7. A founder event is a type of genetic bottleneck, meaning that the population size is very small. This leads to high amounts of genetic drift. Other bottlenecks can occur if a large population faces a crisis and much of the population is killed or otherwise prohibited from reproducing. How would this simulation be different for a population on the mainland that is reduced to a very small population? How would it be the same?





Notes:

PREP:
Room
Set-up

TIME:
1-2 class
periods

TYPE:
Research/
Presentation

Species Protection

Kit Materials:

Instructor Resources:

• Specimen "Instant Expert" Cards
• class access to all other resources

Classroom Transformation:

• Arrange room for presentation of displays.

Specimens:

• All

Supplemental Materials:

• Poster creation materials: large post-it paper/ butcher paper, markers, glue, ribbon, etc.

Curriculum Connections:

LANGUAGE ARTS

7th-8th Grade
Standard 2 (Writing): Persuasive Writing
Standard 3 (Inquiry/Research/Oral Presentation): Reports and Presentations

SCIENCE

7th Grade
STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a: Predict why certain traits are more likely to offer an advantage for survival of an organism.
b: Cite examples of traits that provide an advantage for survival in one environment but not other environments.
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

Biology Core
STANDARD IV Objective 2d: Analyze bioethical issues and consider the role of science in determining public policy.

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes

Objective 1: Relate principles of evolution to biological diversity.
a: Describe the effects of environmental factors on natural selection.
b: Relate genetic variability to a species' potential for adaptation to a changing environment.

Overview:

Students (individually or in small groups) make a poster of information about their specimen. The classroom can then be made into a Scientific Poster Showcase room where the groups explain reasons why we should preserve these organisms.

Description:

Because of the concern about diminishing biodiversity and global catastrophes, the Fish and Wildlife Services (FWS) of the U.S. Government has asked that students (individually or in small groups) research and present to them one species each. They want to know which species should have priority if the global situation becomes worse and what we can to save the biodiversity of the world. Each student or group is to make a poster presentation about the details of the specimen, its adaptations, and why we should preserve this species. Use drawings, photographs, and persuasive writing to convince FWS that your specimen should be at the top of the list of preserved species. Teachers may want to allow students to spend time researching their specimen online or at home if they want the students to learn more about the organism than is described on the specimen card. Features of the poster presentation could include:

- Habitat, diet and other lifestyle information
- Adaptations of the organism contributing to biodiversity
- Effect of the specimen on its environment
- Plan of action for preserving this species

The desks or tables need to be arranged so that the classroom has a station for each specimen group. For the first 30 minutes, half of the class (leaving at least one person from each group to man their stations) visits the other posters and asks the researchers about the species which they are trying to protect. Students who are visiting fill out the provided handout as they learn about each species. Researchers answer the questions to the best of their ability and try to persuade their peers support their species. Students vote on the posters based on the following categories:

- Most creative
- Most humorous
- Most informative
- Most Scientific
- Most interactive

Switch roles for the last 30 minutes of class and repeat the process. Feel free to use the presentation rubric to grade the presentations.

Alternatives:

• Students produce a television commercial promoting their species.

The following information is courtesy of Penn State University found at: http://www.writing.engr.psu.edu/posters.html

Posters are a special type of presentation. When well designed, they are not simply journal papers pasted onto boards. Nor are they mounted sets of presentation visuals. Rather, posters, when effectively designed, are something in between.

The purpose of scientific posters is to present work to an audience who is walking through a hallway or exhibit. In poster presentations at conferences, the presenter usually stands next to the poster, thus allowing for passers-by to engage in one-on-one discussions with the presenter.

So what then makes for an effective poster?

- First, the title of an effective poster should quickly orient the audience. Here are some guidelines for poster titles:
  1. Make the title the most prominent block of text on the poster (either center or left justify at the top).
  2. Do not typeset the title in all capital letters (such text is difficult to read).
  3. Use small words such as of, from, with, to, the, a, an, and and to separate details in the title.

  While phrase titles are most common, some scientists and engineers effectively use sentence titles for posters that present one main result. In such titles, state the result in the title and capitalize the words as you would in a sentence. Because the sentence title is a stand-alone, as opposed to being part of a paragraph, the period is generally dropped.

- Second, the poster should quickly orient the audience to the subject and purpose. One good test is whether the audience recognizes the subject and purpose within 20 seconds of seeing the poster. Usually, a poster accomplishes this goal with a well-crafted title and with supporting images. Also, make sure that the type is large enough to be read and that enough contrast exist between the color of the type and poster's background.

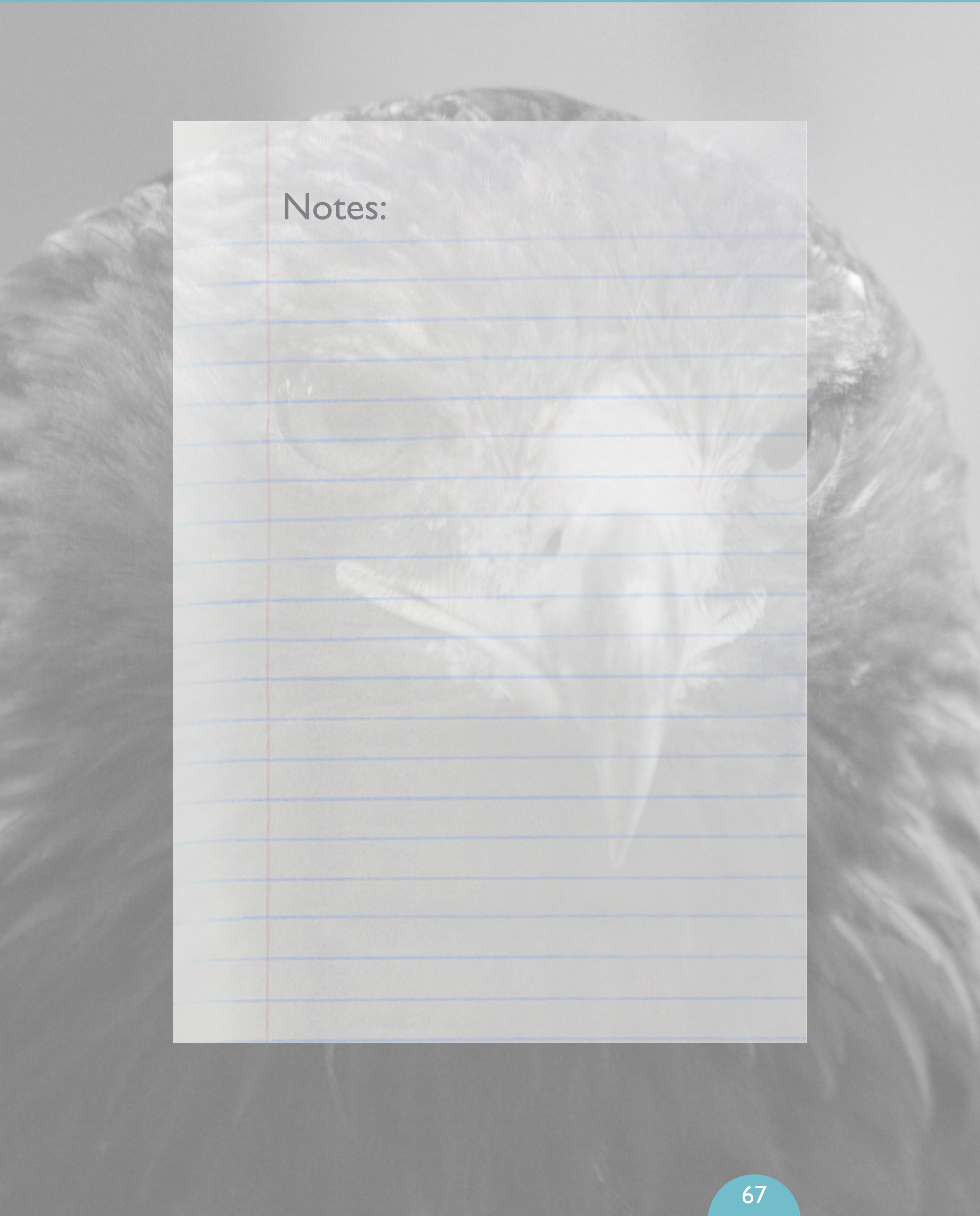
- Third, the specific sections such as the results should be easy to locate on the poster. Once readers recognize what the work is, they decide how much energy to invest into the poster. For instance, many will read only the motivation for the work, the objectives (or goals) of the work, and then the final results. Others, who have a deep interest in the topic, will try to read the poster from beginning to end. Given these different approaches to reading posters, another characteristic of an effective poster is that specific sections are easy to locate.

- Fourth, you should design the individual sections of a poster so that they can be quickly read. Given the distractions that occur while reading posters in a symposium, the poster should not contain large blocks of text. Neither should the poster contain long sentences. If possible, the sections should rely on images: photographs, drawings, and graphs.

Advertising Presentation Rubric

Group Members

	Beginning	Developing	Accomplished	Exemplary	Score
Participation	1 point One main speaker; little participation from other group members	2 points Most group members participate; unequal contributions	3 points All group members have significant participation	4 points Well balanced participation by all group members	
Information Presented	Minimal Information presented	Some information given; not complete or accurate	Complete, accurate information given	Complete, accurate well-organized presentation of information. All the information in the instructions was included.	
Visuals	There are no visuals	There is a picture of the specimen	There is a picture of the specimen and other visuals	The picture of the specimen is interesting, original, colorful. It is accompanied by other visuals that are also interesting, original, and colorful	
Delivery	Poorly organized, hesitant, shows lack of rehearsal	Some organization and rehearsal	Good organization. Smooth. Obviously rehearsed.	Very Professional, polished. Confident. Excellent flow.	
Categories for delivery	No audience eye contact, distracting mannerisms.	Very little eye contact, relies heavily on notes.	Good eye contact, only somewhat dependent on notes.	Excellent eye contact, minimal reliance on notes.	
Most creative Most humorous Most informative Most Scientific Most interactive	Very poor vocal inflection: mumbling, monotone, too soft.	Somewhat lacking vocal inflection. Some stumbling and mumbling.	Projects voice clearly and loudly with good inflection.	Excellent use of voice enhances this presentation: loud, clear, animated, varied pitch.	
Comments:					Total:



Notes:

Additional Resource Activities

Living Lightly on the Planet

The following ativities from these guides match up with objectives from the Utah Science Core Curriculum, but other activities from these guides are also useful and could teach your students important information.
Volume I

- Beyond Carrying Capacity: p. 10 - This activity teaches about sustainable populations
  - Biology Core Standard I Objective 3 e
- The Commons Dilemma: p. 27 - This activity helps students learn to balance individual needs with environmental concerns.
  - Biology Standard 1 Objective 2 d and Objective 3 e
- Our Watery World: p. 57 - Investigate the water cycle
  - Biology Standard 1 Objective 2 a, b, and d
- There is no Away: p. 61 - Learn about underground water supplies and the consequences of pollution.
  - Biology Standard 1 Objective 2 a, b, and d

Volume II

- The Sahel Famine: p. 13 - Learn about the correlation between desertification and human practices.
  - Biology Standard 1 Objective 3 e
- The Rain Forest: Tropical Treasure Trove: p. 21 - Learn more about deforestation and its consequences.
  - Biology Standard 1 Objective 3 e
- The Commons Dilemma: p. 34 - This activity helps students learn to balance individual needs with environmental concerns.
  - Biology Standard 1 Objective 2 d and Objective 3 e
- Changing Water Systems to meet our Needs: p. 67 - Learn about human practices and the water supply.
  - Biology Standard 1 Objective 2 b and d and Objective 3 e

Invasive Species of the Great Lakes

This kit contains actual preserved specimens of invasive species in the Great Lakes. There are some activities explained in the materials, but they are focused on a lower grade level. Feel free to use the specimens to teach about competition, limited resources, human practices, etc.

How is a Food Web Organized?

This kit has activities designed to teach food chains and food webs, energy transfer, and different roles in an ecosystem. Look at the instructions for more specific details.

Biomes of the World in Action

These short videos cover many different ecosystems, although the dialogue and activities are designed for elementary school students. Each video is approximately 23 minutes each.