LESSON 3: BIODIVERSITY BASICS

LENGTH: 60 MINUTES

GRADES/AGES: GRADES 3-7

Lesson Overview:
Discover how biodiversity is calculated by using candy, then calculate biodiversity of a model of the Rocky Mountain forests. Research species that live in this ecosystem and play a whole-class game to explore biodiversity.

Note: This lesson uses a general Rocky Mountain forest ecosystem as an example. This can be modified for a local ecosystem using the blank template provided.

LEARNING OBJECTIVES

Students will be able to:

1. Explain how biodiversity is calculated.
2. Demonstrate how biodiversity is calculated using simulated ecosystems.
3. Identify the importance of a diverse biological world.

DIRECTIONS:

1. Research species of the Rocky Mountain forest.
   a. Assign each student a different species from the Rocky Mountain Region Species List. Tell your students that the species on this list are only a small representation of the biodiversity of the region.
   b. Have your students use the internet to complete the Species Research worksheet on the species they were assigned. It is important that each student learns how their species is connected to other plant and animal species in this ecosystem.
      Optional: Have students transcribe their research onto the smaller species research cards. These can then be turned into nametags for a food web activity.

2. Play a species “Who Am I?” game and explore biodiversity.
   a. Provide each student with the Rocky Mountain Forest Region Species List.
   b. Have one student at a time present their research to the class. Have each student share three things they learned about their species. Have the other students guess what species on the list they have. (If students already know who was assigned each species, collect the Species Research worksheets and redistribute them randomly. Each student would then present another classmate’s research.)
   c. Discuss as a whole group how all of these species are connected.
   d. Define biodiversity or biological diversity (how diverse and healthy an ecosystem is) in a large group discussion. Guide students towards defining the term and provide the definition if needed. Have students conclude the importance of biodiversity in an ecosystem.

3. Calculate a biodiversity index by counting candy.
   a. Explain to students that a biodiversity index is measured by counting the number of species in an area as well as the number of individuals in each population. Explain that there are different formulas or ways to calculate biodiversity.
   b. Individually or in pairs, have students calculate the biodiversity of a package of colorful candy using the Candy Biodiversity Worksheet. (Two different difficulty levels are available. Directions are on the worksheets.)
   c. Have students share their final calculations with the rest of the class.
   d. Discuss the biodiversity of the entire classroom’s candy. If each bag of candy was a small sample area within the classroom candy ecosystem, was each bag of candy a good representation of the entire classroom? Which bag of candy has the most biodiversity? Which had the least?
4. Measure biodiversity of a model of the Rocky Mountain Forest Region.

a. Have your students use the same methods from the candy biodiversity activity to calculate the biodiversity index of a representation of a Rocky Mountain Forest Region.

b. Before this activity: Cut small squares of paper and place these squares in four different envelopes using the Biodiversity Model Table as a key. NOTE: Each envelope represents a different sample area of study. Different colors indicate different species. Each square in each envelope is one organism.

c. Explain to your class that in this activity, they will be imagining that they are analyzing data collected from ecologists. During their research, the scientists collected data from four sample areas (A, B, C, and D).

d. Individually or in pairs, have students calculate the biodiversity of one of the four study areas using the Rocky Mountain Forest Biodiversity Worksheet. (Two different difficulty levels are available. Directions are on the worksheets).

e. Have students share their final results with the class.

f. Discuss the biodiversity of the entire Rocky Mountain Forest model. If each envelope represents a small sample area within the ecosystem, was each area a good representation of the entire ecosystem? Which area has the most biodiversity? Which had the least? Why do scientists collect data from multiple sample areas?

**Assessment:**

Review Species Research Worksheets for accuracy and completion.

Review Candy Biodiversity worksheets for accuracy and completion.

Review Rocky Mountain Forest Biodiversity worksheets for accuracy and completion.

Have students write a one-sentence summary of why biodiversity is important to ensure a healthy ecosystem.

**Extending the Learning:**

Research, read about, and discuss the biodiversity of local ecosystems. Have your students learn about threatened species, how their decline impacts other species, and what conservation projects are planned to ensure your local biodiversity.

Conduct or participate in a BioBlitz.

**PREPARATION:**

**MATERIALS YOU PROVIDE**

- Pencils
- Small pieces of colored paper divided into four envelopes
- Candy

**RESOURCES PROVIDED**

Handouts and Worksheets

- Candy - Basic Biodiversity Index Worksheet (one per student)
- Candy - Simpson Biodiversity Index Worksheet (one per student)
- Rocky Mountain Forest - Basic Biodiversity Index (one per student)
- Rocky Mountain Forest - Simpson Biodiversity Index (one per student)
- Rocky Mountain Region Species List (one per student)
- Species Research Worksheet (one per student)
- Species Research Cards
REQUIRED TECHNOLOGY

- Internet Access: required
- Tech Setup: several computers for student research

BACKGROUND AND VOCABULARY:

BACKGROUND INFORMATION

Biodiversity measures all the different kinds of living organisms in an ecosystem or area. Biodiversity includes all life, even microscopic organisms. Biodiversity is measured using different biodiversity indexes. These calculations vary from simple to complex, but all include the number of different species and the number of individuals in the area of study. Biodiversity can also include genetic diversity among a species.

Ecosystems with greater biodiversity are generally stronger and more resistant to disaster than those with fewer species. When disease, fire, or climate change affects an ecosystem, those communities with greater numbers of different species have a higher likelihood of having species that are able to survive under the new conditions. Biodiversity is important because all living things are connected. When one species is removed from an ecosystem, those areas with greater biodiversity are more likely to succeed. Cold northern ecosystems tend to be naturally less diverse than tropical ecosystems. Some scientists suspect that northern ecosystems will be less resilient in the face of climate change because the loss of even a single species will have a greater effect on the system.

Humans affect biodiversity by destroying natural habitats and adding to climate change. As habitat size decreases, ecosystems can hold fewer individuals and genetic diversity decreases. A greater variety in genes among a population can help species survive disease and changes in habitat. Around the world, people are helping to protect biodiversity by protecting threatened species and habitats.

For more information from National Geographic on biodiversity visit: http://education.nationalgeographic.com/education/encyclopedia/biodiversity/?ar_a=1

Prior Knowledge

Ecosystems

VOCABULARY

<table>
<thead>
<tr>
<th>Term</th>
<th>Part of Speech</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Biodiversity Index</td>
<td>noun</td>
<td>The number of species in the area divided by the total number of individuals in the area.</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Noun</td>
<td>A measurement of how diverse and healthy an ecosystem is by measuring all the different kinds of living organisms in an ecosystem or area.</td>
</tr>
<tr>
<td>Biodiversity index</td>
<td>Noun</td>
<td>A formula that describes the amount of species diversity in a given area.</td>
</tr>
<tr>
<td>Genetic diversity</td>
<td>Noun</td>
<td>The variation in genes and combination of genes within a population.</td>
</tr>
<tr>
<td>Individual</td>
<td>Noun</td>
<td>A single organism.</td>
</tr>
<tr>
<td>Organism</td>
<td>Noun</td>
<td>An individual plant, animal, or other form of life.</td>
</tr>
<tr>
<td>Population</td>
<td>Noun</td>
<td>Many organisms of the same species in one geographic area.</td>
</tr>
<tr>
<td>Simpson Index of Diversity</td>
<td>Noun</td>
<td>[ D = \sum_{i=1}^{n} \frac{n_i(n_i - 1)}{N(N - 1)} ]</td>
</tr>
<tr>
<td>Species richness</td>
<td>Noun</td>
<td>The number of different species in an ecosystem.</td>
</tr>
</tbody>
</table>
CANDY • BASIC BIODIVERSITY INDEX

Calculate the biodiversity index (or how diverse and healthy an ecosystem is) of a bag of candy. Each different colored candy is a different species in your candy ecosystem. The number of each colored candy is the number of organisms of that species in the candy ecosystem.

Directions:
Count how many different colors of candy you have. Record the name of each color in the first column. Record the total number of colors in the last box of the first column.

Count how many of each color candy you have. Record that number in the second column.

Count the total number of candies. Record that number in the last box of the second column.

<table>
<thead>
<tr>
<th>CANDY COLOR</th>
<th># OF THAT COLOR CANDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Species)</td>
<td>(Population)</td>
</tr>
</tbody>
</table>

TOTAL # OF COLORS:  
TOTAL NUMBER OF CANDIES:

How many different colors of candy do you have?

How many candies total do you have?

Calculate the biodiversity index for your candy:
TOTAL # OF COLORS ÷ TOTAL NUMBER OF CANDIES = BIODIVERSITY INDEX

_________________________ ÷ ________________________ = ________________________

Compare your biodiversity index to your classmates. Is your bag of candy rich in diversity? Why or why not?
CANDY • SIMPSON BIODIVERSITY INDEX

Calculate the biodiversity index (or how diverse and healthy an ecosystem is) of a bag of candy. Each different colored candy is a different species in your candy ecosystem. The number of each colored candy is the number of organisms of that species in the candy ecosystem.

Directions:
Count how many different colors of candy you have. Record the name of each color in the first column. Record the total number of colors in the box A of the first column.

Count how many of each color candy you have. Record that number in the second column.

Count the total number of candies. Record that number in box B of the second column.

Calculate n(n-1) for each number in the second column. (Subtract each number in the second column by 1, then multiply it by the original number.) Record each answer in the third column.

<table>
<thead>
<tr>
<th>CANDY COLOR</th>
<th># OF THAT COLOR CANDY</th>
<th>n(n-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: Red</td>
<td>4</td>
<td>4 x (3) = 12</td>
</tr>
</tbody>
</table>

(A) TOTAL Number of colors: (Richness)
(B) TOTAL Number of Candies: (Individuals)
(C) TOTAL

Calculate the Simpson Index of Diversity for your bag of candy. The equation for this method is: \[ D = \sum \frac{n_i(n_i - 1)}{N(N-1)} \]

Where:
\( D \) is the index you are calculating
\( n \) is the number of individuals of a given species
\( N \) is the total number of individuals present in your sample

Calculate the Simpson Index of Diversity. Show your work and answers below.

Subtract the total number of species/colors (number in box A) by 1.

Multiple this number by the total number of species/colors (number in box A).

Divide the sum of n(n-1) (number in box C) by this answer.

The answer is D value which ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity. Describe the diversity of your bag of candy and how you came to your conclusion.
ROCKY MOUNTAIN FOREST • BASIC BIODIVERSITY INDEX

Calculate the biodiversity index (or how diverse and healthy an ecosystem is) of the Rocky Mountain Forest ecosystem. Each square in each envelope is one organism.

The different colors of squares are different species in the ecosystem.

The population is the total number of each colored square.

The total number of squares is the total number of organisms (of all species) in the ecosystem.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>POPULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Colors)</td>
<td>(# of squares of each color)</td>
</tr>
</tbody>
</table>

Directions:
Pick one of the four envelopes. This is one sampling area of the Rocky Mountain Forest ecosystem.

Count how many different types species are in the envelope. Record the name of each species in the first column. Record the total number of species in the last box of the first column.

Count how many of organisms of each species are in the envelope. This is number is the population. Record that number in the second column.

Count the total number of organisms. Record that number in the last box of the second column.

TOTAL # OF SPECIES:

How many different species are in your sampling area?

What species has the largest population?

How many organisms total are in your sampling area?

Calculate the biodiversity index for your sampling area:
TOTAL # OF SPECIES ÷ TOTAL NUMBER OF ORGANISMS = BIODIVERSITY INDEX

TOTAL NUMBER OF ORGANISMS:

Compare your biodiversity index to your classmates and answer the following questions.

Is your sampling area rich in diversity? Why or why not?

Do all sampling areas have the same biodiversity index?

Would taking just one sample of the entire ecosystem give you an accurate picture of the biodiversity? Why or why not?

What can scientists use this biodiversity index for?
### ROCKY MOUNTAIN FOREST • SIMPSON BIODIVERSITY INDEX

Calculate the Simpson Biodiversity Index (or how diverse and healthy an ecosystem is) of the Rocky Mountain Forest ecosystem. Each square in each envelope is one organism.

The different colors of squares are different species in the ecosystem.

The population is the total number of each colored square.

The total number of squares is the total number of organisms (of all species) in the ecosystem.

**Directions:**

Pick one of the four envelopes. This is one sampling area of the Rocky Mountain Forest ecosystem.

<table>
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<th># OF THAT COLOR (Population)</th>
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<td></td>
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**Calculate the Simpson Index of Diversity for your sampling area.**

The equation for this method is: \[ D = \sum_{i=1}^{S} \frac{n_i (n_i - 1)}{N(N-1)} \]

Where:

- \( D \) is the index you are calculating
- \( n \) is the number of individuals of a given species
- \( N \) is the total number of individuals present in your sample

Calculate the Simpson Index of Diversity. Show your work and answers below.

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Subtract the total number of species (number in box A) by 1.

Multiple this number by the total number of species (number in box A).

Divide the sum of n(n-1) (number in box C) by this answer.

The answer is D value which ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity. Describe the diversity of your sampling area and how you came to your conclusion.
# ROCKY MOUNTAIN REGION SPECIES LIST

## Mammals
- Beaver (*Castor canadensis*)
- Black Bear (*Ursus americanus*)
- Bobcat (*Felis rufus*)
- Deer Mouse (*Peromyscus maniculatus*)
- Elk (*Cervus elaphus canadensis*)
- Ermine (*Mustela erminea*)
- Gray Wolf (*Canis lupus*)
- Grizzly Bear (*Ursus arctos*)
- Least Chipmunk (*Tamias minimus*)
- Marten (*Martes americanus*)
- Moose (*Alces alces*)
- Porcupine (*Erethizon dorsatum*)
- Red Fox (*Vulpes vulpes*)
- Snowshoe Hare (*Lepus americanus*)
- White-tailed Deer (*Odocoileus virginianus*)

## Birds
- Common Raven (*Corvus corax*)
- Canada goose (*Branta canadensis*)
- Gray Jay (*Perisoreus canadensis*)
- Mountain chickadee (*Poecile gambeli*)
- Bald eagle (*Haliaeetus leucocephalus*)
- Osprey (*Pandion haliaetus*)

## Reptiles
- Tiger salamander (*Ambystoma tigrinum*)
- Western chorus frog (*Pseudacris triseriata*)
- Northern Leopard frog (*Rana pipiens*)
- Western terrestrial garter snake (*Thamnophis elegans*)

## Fish
- Colorado River cutthroat trout (*Salmo clarki pleuriticus*)
- Yellowstone cutthroat trout (*Salmo clarki*)
- Rainbow trout (*Salmo gairdneri*)
- Brown trout (*Salmo trutta*)
- Eastern brook trout (*Salvelinus fontinalis*)

## Plants
- Rocky Mountain Juniper (*Juniperus scopulorum*)
- Quaking Aspen (*Populus tremuloides*)
- Red Osier Dogwood (*Cornus sericea ssp. sericea*)
- Heartleaf Arnica (*Arnica cordifolia*)
- Colorado Blue Columbine (*Aquilegia caerulea*)
SPECIES RESEARCH

Find the following information about the species you were assigned that calls the Rocky Mountain forests home.

Common name:
Scientific name:
Plant/Animal Family:
Type of habitat:

Physical characteristics:

**Animals only:**
Circle the term(s) that best describe this species:
Herbivore / Carnivore / Omnivore
Predator / Scavenger / Prey
Diet:

**Plants only:**
Animals that feed on this plant:

One interesting fact about this species:

Draw a picture of the species:
**SPECIES RESEARCH**

Common name:  
Scientific name:  
Plant/Animal Family:  
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Physical characteristics:  

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