



Dividends from Diversity?

Overview

This lesson takes the student from understanding the meaning of biodiversity to understanding how important it is in real ecosystems. Using the insects captured during the BEST Plots Invertebrate Diversity Protocol, students play Bug Bingo and have fun while recognizing differences in diversity from place to place. Then, students play the Biodiversity Stock Market, to demonstrate the importance of biodiversity and the consequences of eliminating diversity. Additionally, the game will demonstrate the many economic benefits provided by high levels of biodiversity through valuable ecosystem services.

Objectives

At the conclusion of the lesson, students will be able to:

- Understand what biodiversity means in the scientific community
- Recognize several insects to order
- Understand that diversity differs from place to place, and is declining.
- Understand that biodiversity has economic and social benefits
- Understand that high levels of biodiversity improve ecosystem productivity and stability
- Recognize that healthy ecosystems provide people with a variety of services that have a substantial economic value.

Length of Lesson

This lesson can be divided over two class periods or given as one 70 minute session

Grade Levels

Middle School

Standards covered

S.RS.06.17
L.EC.06.22
L.EC.06.41
L.EC.06.42
S.RS.07.17

Materials

- “Dividends from Diversity” powerpoint
- “Invertebrate Guide” powerpoint
- Poles
- Insect Sticky Traps
- Invertebrate Diversity Protocol (from BEST plots binder)
- Bugs Galore Cards (4 – or more depending on class size) (available as PDF)
- Biodiversity Stock Market rule sheet and score sheet

Background

Biodiversity is a broad concept that is instantly recognized but not as easily understood. While there are *at least* two-million species of biological organisms in the world, levels of biodiversity are different in different parts of the world, and in different habitats (e.g., grassland vs. forest). For example, several “biodiversity hotspots” have been identified throughout the world, such as many areas near the equator. This is known as the “latitudinal diversity gradient,” where areas of lower latitude tend to have higher diversity than areas of higher latitude.

Biodiversity can also vary at much smaller scales, such as across a county in Michigan. These differences can be due to inherent qualities of a specific habitat, but are often the result of land use patterns. The destruction or degradation of habitat is frequently the main determinant in the level of biodiversity at a site. Habitat destruction supplies the first letter to the acronym “HIPPO” that describes five reasons that biodiversity declines. The other four are Invasive species, Pollution, human over-Population, and Over-harvesting. Due largely to these pressures, scientists predict that 30% of species alive in 2000 will be extinct by 2050.

Faced with a global decline in biodiversity, it is critical to understand the importance of biodiversity. High levels of biodiversity can help improve ecosystem productivity. When there are many species present in a given habitat, each specializing on different resources, they are able to utilize resources more completely. Additionally, some species may actually help the growth of other species; a process known as “facilitation”. Ecosystems with higher levels of biodiversity may also benefit from increased stability. The presence of many different species often makes it more difficult for non-native species to successfully invade. Furthermore, high diversity may make ecosystems more resilient toward diseases and other disturbances. If one species is hit with a disease, there are still many other species that can keep the ecosystem functioning.

The benefits of biodiversity and healthy ecosystems can be felt even more directly through numerous ecosystem services. These services include providing food resources, water and air purification, potential medicines, ecotourism, seed dispersal, and pollination. These services have a substantial economic value which has been estimated at approximately \$3 trillion per year.

Activities of the session

1. What is biodiversity? Introduce the concept of biodiversity and gauge students conception of what it means.
2. **Play Bugs Galore!**. This game involves using the Invertebrate Diversity Protocol from the BEST plots binder.
3. Reflect on differences in different types of insects – you can compare switchgrass to mixed prairie, or any of the treatment combinations used in the BEST plots. If there are no noticeable differences, discuss why. (One possible explanation is that invertebrate diversity may not differ on the scale of the BEST Plots.)

4. Discuss how levels of biodiversity differ from place to place and are declining.
5. **Play Biodiversity Stock Market (see attached rule and score sheet)**
6. Reflect on the strategies used during the game. Did they work? Why or why not?
7. Wrap-up. Discuss the consequences of biodiversity loss – ecosystem services, stability

Resources

<http://science.howstuffworks.com/environmental/life/evolution/mass-extinction1.htm>

<http://en.wikipedia.org/wiki/Biodiversity#Threats>

http://en.wikipedia.org/wiki/Ecological_effects_of_biodiversity

http://en.wikipedia.org/wiki/Ecosystem_services

<http://sharonfalsetto.suite101.com/the-importance-of-biodiversity-a214198>

Extensions and Modifications

1. Different habitats, fields, etc. could be sampled instead of the BEST Plots
2. Stock market game could be expanded to include more direct human intervention (for example, spraying pesticides). Could also be expanded to include species adaptation and evolution (species could evolve resistances to diseases).
3. For older students (high school), the Shannon-Weiner diversity index (H') could be used to compare samples. This is an “evenness” index that calculates a number that reflects both how many species (or orders) are in a sample, and how evenly the abundance of individual organisms is distributed among them ($H' = \sum p_i * \ln(p_i)$; where p = proportion of individuals of species i in sample).

Assessment

Students will be assessed with thought questions and discussion on both activities during the session.

Insect Bingo

Number of Players/Groups: 2-4

Materials:

1. One bingo card for each player/group
2. One set of real live insects, representing a plot or group of plots (from BEST Plots) or some discreet area for each player/group (from sticky traps and/or pitfall traps and/or other insect collection techniques.
3. Invertebrate guide (<http://kbsgk12project.kbs.msu.edu/blog/2011/09/14/biomass-and-biodiversity-protocols/>): One print-out per player/group.
4. (Optional) Insect key or identification book.
5. Bingo “dots”, little pieces of paper, pennies, or anything to mark bingo squares

Background: This game is intended to make insect identification, for the BEST Plots or otherwise, more fun than it already is. It is played the way regular bingo is played. If using samples from BEST Plots (see Invertebrate Biodiversity , it is acceptable to groups samples based on one of the three variables being studied in the BEST Plots: switchgrass vs. mixed prairie, fertilized vs. unfertilized, harvested vs. unharvested.

Setup: Break up class into groups of 3-4 students, and hand out one card and one insect guide to each student. For pedagogical reasons, one option is to not tell the students which area the sample(s) is from.

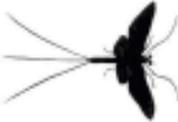
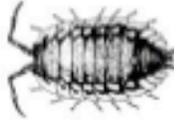
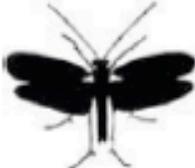
Rules: Because all the “numbers” (=insects) for the bingo card are distributed at once, this is not a timed game, so it is possible for more than one group to “win.” There are options for tie-breakers.

The game starts by distributing insect samples to each player/group. Ask students to identify insects to order, and sort the entire sample into groups as such. As soon as they identify an order that is on their card, they should set a single example aside and put a “dot” on the appropriate square on the card.

“Winning”: By the end of the allotted time, or once all of the samples have been identified, have students count the number of squares they have filled on their sheet.

Optional: Students need to count numbers of each invertebrate order for the BEST Plots Protocol. You could also incorporate this into the game, and award the team with the single order with the highest number of individuals.

Discussion: Have students discuss why there were differences in the number of orders and number of individuals between the samples. What was different about the different places the samples were placed?

<p>Ants, Bees, Wasps (Hymenoptera)</p> 	<p>Bugs, Cicadas, Aphids (Hemiptera)</p> 	<p>Earwigs (Dermaptera)</p> 	<p>Cockroaches (Blattodea)</p> 	<p>Spiders, Daddy long legs, Ticks (Arachnida)</p> 
<p>Beetles & Weevils (Coleoptera)</p> 	<p>Flies and Mosquitos (Diptera)</p> 	<p>Dragonflies and Damselflies (Odonata)</p> 	<p>Springtails (Collembola)</p> 	<p>Mayflies (Ephemeroptera)</p> 
<p>Lacewings (Neuroptera)</p> 	<p>Grasshoppers, Katydid, Crickets (Orthoptera)</p> 		<p>Termites (Isoptera)</p> 	<p>Centipedes (Chilopoda)</p> 
<p>Praying mantids (Mentodea)</p> 	<p>Unknown ?</p>	<p>Walking Sticks (Phasmida)</p> 	<p>Pillbugs (Malacostraca)</p> 	<p>Scorpionflies (Mecoptera)</p> 
<p>Snails and Slugs (Gastropoda)</p> 	<p>Caddisflies (Trichoptera)</p> 	<p>Earthworms (Clitellata)</p> 	<p>Butterflies and Moths (Lepidoptera)</p> 	<p>Millipedes (Diplopoda)</p> 

Biodiversity Stock Market

Number of Players: 2-4

Materials:

1. Assorted color squares of construction paper (orange, brown, purple, blue). Alternatively assorted colored toothpicks or beads will also work.
2. Deck of 13 chance cards. Chance cards can be cut out of the sheet attached to this lesson plan.
3. Score sheet.

Background: The purpose of this game is to demonstrate the importance of biodiversity. Biodiversity has been declining across the planet due to a variety of factors including habitat loss, introduction of invasive species, and climate change. This loss of biodiversity forces governments and the public to ask the question “is biodiversity worth preserving”.

Players of this game step into the role of a large land owner or farmer. As a player, you must decide how best to invest your resources. As a landowner you can have up to four different species living on your land at the same time. Each species has a different economic value associated with it, and it is up to you to decide whether to invest all of your land’s resources on only one species or on mixture of species. Along the way players may encounter chance events that have different impacts depending on what is living on their lands. The overall objective of the game is to become the landowner with the most valuable land (the player with most points at the end of the game). It is up to the players to decide whether biodiversity is important.

Setup: Before beginning a game cut out the 13 chance cards attached to this lesson. The deck of chance cards should be shuffled and placed face down in front of the players. Additionally, the assorted color squares (orange, brown, purple, blue) should all be placed in a pile in front of the players.

Rules: The game consists of six rounds, each round simulating one year. The first round begins with each player selecting 4 of the colored squares from the pile. These squares represent individuals from 4 different species (each color is a different species). Each species has its own economic/point value:

- 1 Orange = 5 points
- 1 Brown = 4 points
- 1 Purple = 4 points
- 1 Blue = 3 point

The player can select individuals from the same species, or from a mix of species. After selection, a chance card is flipped over and all players read and follow any instructions on the card. The round ends when players record how many individuals of each species are living on their land, and the player calculates their land’s current worth using the point values above and any instructions given by the chance cards.

The remaining 5 rounds follow the same instructions as the first round with the exception that players can only select **1** new individual from the pile at the start of each round. At the end of the last round the player with the most points has the most valuable land and wins the game!

Biodiversity Stock Market Score Sheet

Please record the number of individuals from each species you have as well as your point total at the end of each round. *When calculating point total be sure to apply any instructions from chance cards.*

Player Name:

Round 1 _____ Orange, _____ Brown, _____ Purple, _____ Blue, _____ Point Total

Round 2 _____ Orange, _____ Brown, _____ Purple, _____ Blue, _____ Point Total

Round 3 _____ Orange, _____ Brown, _____ Purple, _____ Blue, _____ Point Total

Round 4 _____ Orange, _____ Brown, _____ Purple, _____ Blue, _____ Point Total

Round 5 _____ Orange, _____ Brown, _____ Purple, _____ Blue, _____ Point Total

Round 6 _____ Orange, _____ Brown, _____ Purple, _____ Blue, _____ Point Total

Thought questions:

1) What was your investment strategy during this game? Did it work?

Please play through the game a second time:

Round 1 _____ Orange, _____ Brown, _____ Purple, _____ Blue, _____ Point Total

Round 2 _____ Orange, _____ Brown, _____ Purple, _____ Blue, _____ Point Total

Round 3 _____ Orange, _____ Brown, _____ Purple, _____ Blue, _____ Point Total

Round 4 _____ Orange, _____ Brown, _____ Purple, _____ Blue, _____ Point Total

Round 5 _____ Orange, _____ Brown, _____ Purple, _____ Blue, _____ Point Total

Round 6 _____ Orange, _____ Brown, _____ Purple, _____ Blue, _____ Point Total

2) Did you change your strategy for the second game?

3) Does biodiversity provide any benefits to humans?

4) Do you think that preserving biodiversity is important? Why?

Economy

The economic demand for orange has increased.

Orange is now worth 6 points.

Invasive Species

A non-native pest is attempting to invade.

If you have less than 3 species the pest successfully invades. The point value for each species is reduced by 1.

Disease

A disease has spread through the orange species.

Lose 3 orange individuals.

Disease

A disease has spread through the brown species.

Lose 2 brown individuals.

Disease

A disease has spread through the purple species.

Lose 1 purple individual.

Disease

A disease has spread through the blue species.

Lose 1 blue individual.

Disease

A devastating disease has spread through your land.

If you have a monoculture (only 1 species), lose all individuals.

Ecosystem Service

If you have an intact ecosystem (all 4 species) you benefit from services like water purification and nutrient recycling.

Add 10 points to total score.

Ecotourism

If you have an intact ecosystem (all 4 species) you can attract tourists.

Add 5 points to total score.

Biofuels

Scientists investigate using the purple species as a biofuel.

Purple is now worth 5 points.

Medicine

Scientists find compounds in the blue species that can be used in medicine.

Blue is now worth 5 points.

Facilitation

Orange and purple depend on brown to grow successfully.

If you have fewer than 2 brown, then lose 1 orange and 1 purple individual.

Complementarity

If you have all 4 species you are able to use your lands resources more completely.

Add 5 points to your total score.