



## **Biodiversity: Earth's Most Valuable Resource**

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**Introduction:** In this lesson, students will learn about biodiversity outside the realm of widely-known endangered species. They will look at the value of biodiversity and how human activity is leading to its decline. Through their own research, they will discover the extent to which climate change can have an impact on biodiversity.

**Grade Level & Subject:** Grades 9-12. Environmental Science, Earth Science, Biology, Civics, Social Studies, Government.

**Length:** Two class periods, with option for longer class project.

### **Objectives:**

- Learn to define and explain the value of the three major types of biodiversity.
- Examine the impact of human activity and climate change on biodiversity.

**Assessment:** Students can be assessed based on their participation in class discussion and on their understanding of the topic. Understanding can be evaluated based on a provided worksheet that students will fill out.

### **Standards<sup>1</sup>:**

- NSS-EC.9-12.1 Scarcity
- NL-ENG.K-12.4 Communication Skills
- NL-ENG.K-12.7 Evaluating Data
- NL-ENG.K-12.8 Developing Research Skills
- NM-DATA.9-12.1: Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer
- NS.9-12.1 Science as Inquiry
- NS.9-12.3 Life Science
- NS.9-12.6 Personal and Social Perspectives
- NSS-C.9-12.5 Roles of the Citizen
- NSS-G.K-12.5 Environment and Society
- NT.K-12.5 Technology Research Tools

### **Materials:**

- Computers with internet access.

### **Warm-up: The Value of Biodiversity**

**Biodiversity** is the abundance of different species and ecosystems in nature. An **ecosystem** is an ecological community, which together with its environment, functions as

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<sup>1</sup> Education World (2008) *U.S. National Education Standards*. Retrieved March 3, 2008, from <http://www.education-world.com/standards/national/toc/index.shtml>

a unit. Currently, biodiversity is decreasing at an alarming rate due to human activities. This is referred to as the “biodiversity crisis.” One example of human impact on biodiversity is the clear-cutting of forests, which destroys established ecosystems and also contributes to the loss of species because clear-cutting destroys the habitat where species live. Another example of human impacts to biodiversity is the effect that climate change, exacerbated by the burning of fossil fuels, has on ocean temperatures and coral reefs. Coral reefs are typically hosts to an abundance of unique species, which can only survive at very specific water temperatures, so small increases in temperature kill coral reefs and all the species that inhabit them.

Now that you have gone over the risks that are being posed to biodiversity at this time, you can look more closely at what biodiversity is and why it is important. Begin by introducing the three levels of biodiversity: genetic biodiversity, species biodiversity, and ecosystem biodiversity. While students might be more familiar with species biodiversity, the other types of biodiversity are equally important. A healthy environment depends on the preservation of genes within a species, species within an ecosystem, and the ecosystem as a whole.

**Genetic biodiversity** is the variation of genes within a species. Genetic biodiversity provides the opportunity for **natural selection**, as those genetic traits that allow species to survive get passed on to the next generation. Without genetic biodiversity, it would be impossible for species to adapt to changing environments<sup>2</sup>. The value of genetic biodiversity can be illustrated using the visual example below.

Begin by placing five apples on a table in the front of the room. Tell the students that each apple has a different genetic trait. For example, the first apple is resistant to bruising, the second apple is the most crispy and juicy, the third apple is easiest to grow, the fourth apple is resistant to disease X, and the fifth apple has an unusually long growing season because it can withstand cold temperatures. Explain that although the apples look the same, they are genetically diverse because they are from different areas of the world, and so through natural selection, these apples eventually adapted particular traits to survive in these particular environments. Through the process of natural selection the apples with the best genes for their habitat survived to pass those traits on to the next generation.

In this hypothetical example, the second, most tasty apple sells the best, so apple farmers begin planting a lot of that one, but not so much of the others (move that apple forward on the desk). This is great for a while, but the tastiest apple is not the best growing apple, so an industrious farmer, named Jo, decides to do some experimenting and mixes the all of the five apple genes together. Now we have an apple that is delicious; easy to grow; has a long growing season; and is resistant to diseases, cold, and bruises. Perfect! (Place the four apples behind the front apple).

Now all of the apple farmers are using this genetically modified species in their orchards. Ask the students to imagine that a new apple disease, called disease Y, is sweeping through farmer’s orchards. What should the farmers do? In the wild, a few individual apples are often resistant to a new disease, and natural selection helps the species repopulate, but because all the apple farmers have cut down other species of apple trees to grow the genetically modified fruit, there are no variations among the

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<sup>2</sup> Australia Department of the Environment, Sport and Territories (1993). *Biodiversity and its Value*. Retrieved March 3, 2008, from <http://www.environment.gov.au/biodiversity/publications/series/paper1/>.

apples, and none of the modified apples have developed a natural resistance to this new disease. Pretty soon the entire apple population will fall. (Put a cloth over the apples. Also, give the apples to students who have participated most in the class discussion).

This example demonstrates the importance of genetic biodiversity in nature, since variations provide for adaptations to changing environments and to activities by humans. It also portrays the importance of ecosystem biodiversity, in that different ecosystems would allow for significantly different apple species to be tailored to the ecosystem, and perhaps one of these ecosystems would have selected for the creation of disease Y-resistant apples. Explain that although this example is highly simplified, humans are artificially selecting species to grow in a **monoculture** (defined as the agricultural practice of growing one single crop over a wide area)<sup>3</sup> all over the world. This is resulting in decreased biodiversity. In addition, human activities are increasing climate change, which is also decreasing biodiversity because environments are changing so rapidly that organisms are not able to adapt fast enough. Instead, they die off. From this perspective, students should see how their activities can directly impact biodiversity.

**Species biodiversity** is defined by the number of species in an ecosystem, whether particular to a region or as part of the collective whole of the Earth. Species biodiversity is necessary to maintain the balance of the world's ecosystems. The importance of species biodiversity can be illustrated by creating a simplified ecosystem with your class, including species such as plants, pollinators, herbivores, carnivores, etc. An example of an ecosystem has been provided at the end of this lesson to print out or recreate in your classroom. Looking at the sample ecosystem, have students consider what would happen if one of the components were removed from the ecosystem. For example, the removal of a pollinator would lead to a shortage of food for the herbivores, which would eventually cause a shortage of food for the carnivores, and eventually lead to the loss of species biodiversity throughout the ecosystem.<sup>4</sup>

**Ecosystem Biodiversity** refers to the number and variety of specific environments around the world. An ecosystem is defined by its geography, climate, soil and water resources, and species. Ecosystem biodiversity is important because it incorporates both genetic and species biodiversity, and allows for the process of natural selection by favoring different genetic traits in particular ecosystems. This leads to the development of unique species over time, including ones that can only be found in one specific area of the world<sup>5</sup>. Different ecosystems also provide different services. For example, wetlands act as a buffer for flooding during storms and remove pollutants from water. A map of the world's ecosystems, as identified by the World Wildlife Fund, can be found here: <http://www.worldwildlife.org/wildfinder/searchByPlace.cfm>. You can look up your own area, print out the map and discuss your ecosystem with the students.

More information on the value of biodiversity can be found here: <http://www.environment.gov.au/biodiversity/publications/series/paper1/>

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<sup>3</sup> Northwestern University Department of Biochemistry (2007). *Monoculture*. Retrieved March 3, 2008, from <http://www.biochem.northwestern.edu/holmgren/Glossary/Definitions/Def-M/monoculture.html>.

<sup>4</sup> Convention on Biological Diversity (2007). *Status and Trends of Global Biodiversity*. Retrieved March 3, 2008, from <http://www.cbd.int/gbo1/chap-01.shtml>

<sup>5</sup> Ibid.

### **Activity One: Species Biodiversity**

**Step 1:** Begin by introducing students to the enormous amount of biodiversity that exists in the world. It is impossible to know how many species there really are, but scientists have already discovered 1,744,000 species, and estimate a total of 14,000,000 species worldwide.<sup>6</sup> Another way to consider the enormity of biodiversity is to look at the list of species that are threatened with the number of species we know of. This list can be found here: <http://www.fws.gov/Endangered/wildlife.html#Species>

**Step 2:** Students will now have the opportunity to research endangered species themselves. Ask them to select one species from the website with which they are not very familiar and discuss why it might be important to biodiversity. Then have them hypothesize what impact climate change could have on this species. For example, the population of Hawaiian monk seals, an endangered species endemic to the Hawaiian Islands, is decreasing because rising sea levels reduce the size of beaches crucial for bearing and raising young.<sup>7</sup> The common cockroach, on the other hand, is likely to increase with climate change due to warmer temperatures, which will enable cockroaches to survive in more places.

This activity could be done in groups or as individuals. In order to guide their research, have students fill out the worksheet provided at the end of this lesson.

**Step 3:** Have students research their selected species to determine its value (economic or ecological), determining the impact that climate change have on the species and the habitat where it lives. For example, the white abalone, a marine snail species, is valued as a food source for marine life and humans alike. It is at risk of habitat loss and increased susceptibility to disease from climate change. After researching their species, students should do a brief write-up as described at the end of the Activity One worksheet.

### **Activity Two: Ecosystem Biodiversity**

**Step 1:** Tell the students that they are responsible for a particular area of rainforest, say 100 acres. Break them into five groups. Each group should represent a position, such as business person, farmer, developer, native inhabitant, and conservationist.

**Step 2:** Have each group develop their position on what to do with the rainforest area. For example, the business person may want to use the resources for industry, the farmer may want to clear the land to grow crops or support livestock, the developer may want to clear the land to develop luxury housing, the native inhabitant may want to maintain the patch the way that it is to support their lifestyle, and the conservationist may want to preserve the patch for its biodiversity. Each group should consider the arguments of the other groups in order to present a good case that will promote their own interests.

**Step 3:** Have the students conduct an informal discussion that will determine the outcome of the area of land. Each student will discuss their position and try to win on the land for their use. Guide their discussion in order to reach a consensus.

**Homework Assignment:** Following the discussion, have each student decide what they would do with the rainforest land, given the option. Have them consider each of the

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<sup>6</sup> Ibid.

<sup>7</sup> Smith, D.M. (Nov. 2007). Hawaiian monk seals endangered. Retrieved March 3, 2008, from [http://endangered-species.suite101.com/article.cfm/hawaiian\\_monk\\_seals\\_endangered](http://endangered-species.suite101.com/article.cfm/hawaiian_monk_seals_endangered).

different positions, and defend their decision. Additionally, ask them what a potential compromise could be made to satisfy each of the different stakeholders.

### **Activity Three: Local Biodiversity and the Scientific Method**

The scientific method is a strategy that scientists use to organize experiments and the information that they acquire. Your students will use the scientific method to test their comprehension of the wealth of biodiversity in your area. The steps of the scientific method are italicized throughout this activity.

**Step 1:** Have students *observe* their area and *formulate a hypothesis* about how many different species they believe they will be able to locate in a local park or other natural environment. Make sure they consider all organisms, including plant life, birds, and insects.

**Step 2:** Allow students to *test their hypotheses* by taking a field trip to a local park or other natural environment and exploring in groups. They can *collect data* by writing down the different species they can find. Note: the students may need to be given a guide to identify species. Afterwards, they can compile and *analyze the data* by creating a master list of species found and discussing what was found.

**Step 3:** *Draw conclusions* by having students do a brief write-up comparing and contrasting the information they found with their initial hypotheses.

**Step 4:** Have students research some of the species they have found to see if any of them are at risk for extinction. Have them draft a policy proposal to help protect this species. An example of how a policy proposal should be formatted can be found at the end of this lesson.

**Assessment:** Students should be assessed on written assignments described in Activities One and Three, and their homework assignment from Activity Two.

**Conclusion:** At the end of this lesson, students should have developed a full understanding of the threat that is posed to biodiversity and the reasons why this is problematic. They should also understand the significance of this on a more personal level after having looked at local biodiversity.

For more information on biodiversity and climate change, see Green Facts about Biodiversity at <http://www.greenfacts.org/en/biodiversity/index.htm> and <http://www.greenfacts.org/en/global-biodiversity-outlook/>.



Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Activity One: Species Biodiversity

You will be asked to select an endangered species to research thoroughly. Please answer the following questions regarding your species.

My endangered species is \_\_\_\_\_.

1. What Domain, Kingdom, Phylum, Class, Family, Order, Genus, and Species are your species? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

2. What environment and part(s) of the world is your species typically found in?

\_\_\_\_\_  
\_\_\_\_\_.

3. Before researching it, write down why you think your species is valuable.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_.

4. Before researching it, write down how you think your species will be impacted by climate change.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_.

5. Now that you have researched it, tell in what way your species is most valuable?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_.

6. Now that you have researched it, how will your species be impacted by climate change? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_.

7. On a separate sheet of paper, write a paragraph on how your research showed different results from your hypotheses. Also, include another paragraph on what else you learned on your species from your research.

Activity Two: Ecosystem Biodiversity  
Format for Policy Proposal

**To:** To whom would their proposal be addressed?

**From:** Students name.

**Statement of Problem:** What issue are they addressing?

**Proposed Solution:** How do they propose to solve it?

**Benefits of Proposed Solution:** What are some of the other options, and why is this solution better than those?

**Major Obstacles to Proposed Solution:** What are the challenges, and some suggestions for overcoming them?

**Major Costs to Proposed Solution:** What will be the biggest expenses for this solution? There is no need for exact numbers, just understanding.

**References:** Where did this information come from?