

## **The Biodiversity Box**

(Biodiversity, Habitat Loss, Invasive Species, and Conservation)

Christopher Dobson, Professor  
Department of Biology, Grand Valley State University  
&  
Megan Gauss  
(GVSU Teacher Graduate)

### **NGSS Elementary Performance Expectations**

- 2-LS2-2. Develop a simple model that mimics the function of an animal dispersing seeds or pollinating plants.
- 2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.
- 3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
- 3-LS4-3. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

### **Objectives:**

Upon the completion of this lesson students will be able to:

1. Define biodiversity.
2. Describe the effect of habitat loss on biodiversity.
3. Explain how the size of nature reserves relates to conservation efforts.
4. Explain the impact of an invasive species on biodiversity.

### **Materials and Setup:**

#### Engage

Construct a "Biodiversity Box" of your own prior to beginning the lesson.

- \* Shoe box
- \* Scissors
- \* Glue or tape
- \* Markers
- \* Construction paper (assorted colors)
- \* Print-outs or drawings of 6 different birds
- \* Stickers (to decorate box and label islands)
- \* Wrapping paper or butcher paper

To create a Biodiversity Box cut a piece of blue construction paper that fits snugly in the bottom of the box. Next, cut out five oddly shaped pieces of green paper to represent islands (assembly instructions attached). These should all be different sizes and should be labeled A through E, from smallest to largest. Glue or tape these islands to your blue

sheet of paper, and attach the whole map to the bottom of the box. Make sure the edges of the islands are firmly attached to the blue paper to prevent the paper birds (described below) from becoming lodged underneath the islands.

Now print out or draw six small pictures of different birds on construction paper (see assembly instructions). The birds represent different species, so make sure that they are all different shapes and colors. The birds should be no bigger than the size of a quarter. Next write, "Hey Mr. Hurricane in the sea, when will your winds stop pushing me? Just let me land on an island please, and I'll increase its biodiversity!" on a piece of construction paper. Attach the poem to the lid of your box. Enhance the appearance of your box by covering it with wrapping paper and adding colorful stickers or pictures.

### Explore

Students construct their own Biodiversity Boxes to test their predictions about the relationship between island size and species diversity. Their conclusions will be based on analysis of the evidence they collect and record in a data sheet.

- \* Materials for students to construct their own boxes  
(same as materials in *Engage*)
- \* Data sheet (attached) / notebook paper

### Explain

Assess students' knowledge through class discussion and analysis of individual student writing.

- \* Data sheet / notebook paper (from *Explore*)

### Elaborate

Students research invasive species and create an art, or language arts project to illustrate their understanding of the topic.

- \* Internet connection to research invasive species
- \* Books and articles about invasive species
- \* Materials to create a poem, song, drawing, or painting about invasive species

### Evaluate

Formally assess student understanding with a quiz.

- \* Quiz and key (attached)

### **Safety:**

Make sure students have enough space between themselves and others to allow for vigorous shaking of their Biodiversity Boxes.

### **Requisite Knowledge/Skills for Students:**

Students should have a basic understanding that many different types of organisms (species) exist in nature and they interact with and affect one another in various ways.

**Procedure:**Engage*Biodiversity Box Demonstration.*

15-20 min.

1. Once you have made a Biodiversity Box, present it to your students, showing them the islands inside the box, as well as the birds. Point out that each island is a different size and shape, and each bird is a different design and color. Explain that each of the six birds represents a different species. Tell students the birds have become lost at sea during a hurricane and hope to make it to an island to survive. Place the birds inside the box, close the lid, and chant the poem that is written on top. While doing so, shake the box vigorously to simulate a hurricane carrying birds out to sea. Shake the box in a side-to-side motion, several times, keeping it horizontal, or parallel to the ground. This motion should spread the birds out evenly and randomly in the box and not allow them to accumulate in one location, such as a corner. Without letting your students see inside the box, peek under the lid and act surprised.
2. Ask your students what they think happened. Lead students to consider water and island landings, as well as the implications of not landing on an island. After several responses, tell students they will have to make their own box to find out. Specifically ask students to predict where most of their birds will land and why.

Explore*Make a Biodiversity Box and Test Predictions.*

45-55 min.

1. Instruct students how to make a Biodiversity Box of their own, and encourage them to be creative in decorating it. Before they simulate their own hurricane, have them write a paragraph explicitly predicting what they think will happen. Remind students to think about where the birds are most likely to land and to describe why they think this will happen.
2. Tell students they will now test their predictions. Describe how to properly shake the box to make the test fair (see Engage). Emphasize the importance of shaking the box side to side, keeping it as horizontal as possible. Not doing so will result in biased data (birds clumping together in one or two particular locations). Have students simulate a hurricane, chanting the poem, and then record how many birds land on each island on their data sheet. Tell students that birds touching an island should be counted as having landed successfully. However, if a bird is not touching an island, remind your students that in nature, casualties occur, and that these birds have been lost at sea. Have the class repeat the simulation several times, recording their results on the data sheet.

*Evaluate:* Walk around the classroom to make sure that students are shaking their boxes properly. Review the data sheets to verify that data is being recorded correctly. Check to make sure that students made specific predictions about where birds would be most likely to land.

### Explain

*Compile and Analyze Data.*

20-30 min.

1. Have the class combine their data on the board. Depending on grade level, either average the results, or simply sum the total number of successful colonizations for each island (number of birds that land on or touch an island).
2. Ask students which islands had the most birds land on them and whether or not the results support their predictions (what they expected). Explain to students that the number of species (birds) in a natural habitat (island) is referred to as species diversity, a common way to measure the biodiversity of an area. Ask what island characteristic (size, shape, location) seemed to have the greatest affect on species diversity. If the boxes are shaken properly with the birds being spread out evenly and randomly, larger islands tend to have more species land on them. Ask students why they think this happens. Lead students to the understanding that larger islands represent bigger targets for birds to successfully colonize; it is more likely that birds will land on larger islands than smaller islands. Point out that their results have implications for conserving biodiversity. Explain to students that natural habitats become more and more like isolated “islands” as continued land development leads to habitat loss. Students should be able to predict that larger nature reserves will have more biodiversity than smaller ones. Note that it is possible that other factors, such as island location or shape, may affect the results. For example, islands in the corners may have fewer landings and islands with peninsula-like projections may have more. The concern about island location is potentially addressed by making sure the boxes are shaken properly, in a fashion that distributes the birds evenly and randomly throughout the bottom of the box. An optional discussion could address how island shape might affect species diversity. Students could even assess the affect of island shape by actually making and testing their specific predictions.

*Evaluate:* Ask students to add to their paragraph from the Explore. Have them explain how their predictions were or were not supported. Have them define biodiversity. Ask them to describe how nature reserves are similar to islands and how understanding this can help us to protect biodiversity.

\* As an additional exercise, should the opportunity exist, take students outside to measure species diversity in two natural habitats of different size. Students do not actually need to identify each species; it is enough to recognize various species as different (they can be labeled animal or plant species A, B, C, etc.). Simply keep a running total of the number of new species encountered. Make sure they formally predict which habitat will have the greatest species diversity and that their reasoning is related to their new understanding of habitat (island) size and biodiversity.

### Elaborate

*Investigate the Impact of Invasive Species on Biodiversity.*

1-3 days

1. Tell students that there are some organisms, known as invasive species, which can have an impact on biodiversity. Have students investigate what invasive species are and identify some in their local area. Provide books or articles about invasive species or have students conduct a library or Internet search. The Internet is particularly helpful for determining the current range of various invasive species. Ask students to specifically investigate the effect that invasive species can have on biodiversity, including interactions, such as competition and predation, with native species (local species).

*Evaluate:* After researching invasive species, have students compose a poem, song, drawing, or painting that explains or illustrates their effect on biodiversity. Students should present their projects to the rest of the class.

2. Following the presentations, point out to students that habitat loss and invasive species can act together to put native species under incredible pressure, at times leading to their local extinction from an area. Explain that native species struggle as their natural habitats are fragmented and reduced through land development. The remaining patches of habitat become more like isolated islands. The smaller islands of habitat have fewer resources for species and are more vulnerable to natural disasters, such as forest fires or hurricanes. Adding invasive species to these habitats can be the final straw that pushes native species out of an area. Ask students to add to their paragraph from the *Explain*, specifically describing how invasive species can displace native species in a local habitat.

*Evaluate:* Student responses should explicitly include the concepts of competition and predation and incorporate specific examples of invasive species from their region. Conclude the lesson by giving students a quiz to formally assess their understanding of biodiversity, habitat loss, invasive species, and conservation.

### Evaluate

*Teacher Assesses Student Understanding Throughout Lesson.*

1. *During Explore:* Students make and test predictions about species diversity on islands of different sizes. It is crucial that data is collected and recorded accurately, because they will reach conclusions based on this evidence in the *Explain*. Make sure students are shaking their Biodiversity Boxes from side to side, in a motion parallel with the table. This technique should spread birds throughout the bottom of the box randomly and not allow them to accumulate preferentially in one area of the box. Also make sure that students are accurately counting birds that successfully colonize an island (if the bird is touching an island it counts). Students also write a paragraph describing their prediction before simulating a hurricane. Make sure that their predictions specifically relate to islands somehow (island size, shape, location, etc.).
2. *After Explain:* Students add to their paragraph from the *Explore* and describe how their predictions were or were not supported. Make sure students base their conclusions on the evidence they collected during the *Explore*. Students should be able to define species diversity (the number of different species in a natural

habitat) as one measure of biodiversity (Objective 1). Students should also be able to describe how land development converts remaining natural habitats into isolated patches or islands (Objective 2). Finally, students should be able to explain how the “island” perspective relates to the size of nature reserves in efforts to conserve biodiversity (Objective 3).

3. *During Elaborate:* Students create a song, poem, drawing, or painting to illustrate their knowledge about invasive species. Using their art or language art project, students should be able to convey their understanding that invasive species can decrease the biodiversity of an area (Objective 4).
4. *After Elaborate:* Students take a quiz to demonstrate their understanding of the concepts developed in this lesson. They should be able to define biodiversity (Objective 1). They should also be able to describe the affect of habitat loss on biodiversity (Objective 2). Students should be able to explain how the size of nature reserves will affect efforts to conserve biodiversity (Objective 3). They should also be able to explain the impact of invasive species on biodiversity (Objective 4).

### **Scientific Background for the Teacher:**

This lesson illustrates several ecological topics related to the conservation of biodiversity. The relevant concepts are briefly defined below.

*Biodiversity* describes the great variety of life on this planet, including plants, animals, fungi, and various microscopic organisms. As one measure of biodiversity, *Species Diversity* estimates the number of different species in a particular environment.

*Biogeography* explores the geographic distribution of organisms around the world, including historical explanations for these patterns, basically asking why different species are found where they are.

*Island Biogeography* (MacArthur and Wilson 1967) explains how island size affects species diversity. Large islands, because of more abundant resources and diverse habitats, support more species than small islands. Large islands are also easier targets for species to reach from other islands or the mainland, the sources of colonization. Island biogeography is relevant to current conservation efforts, as natural habitats are lost and fragmented, leaving only “islands” for species to inhabit.

*Invasive Species* are unwanted species from other parts of the world that arrive on boats or airplanes and displace native species. These biological invaders, like the zebra mussel or brown tree snake, act as unusually strong competitors or predators and can dramatically decrease the biodiversity of an area.

### **References:**

MacArthur R. H. and E. O. Wilson. 1967. *The Theory of Island Biogeography*. Princeton University Press, Princeton, New Jersey.

**Data Sheets:****Island**

Trial Number

	A	B	C	D	E
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
<b>Average</b>					

**Island**

Trial Number

	A	B	C	D	E
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
<b>Total</b>					

## Biodiversity Box Assembly Instructions



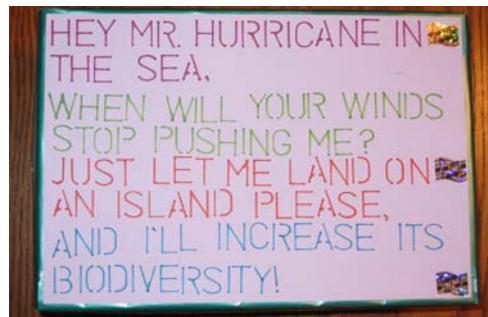
Wrap a shoe box with wrapping paper or cover it with construction paper. Decorate with stickers. Write, “Biodiversity Box” on the outside of the box.

Next, label the box with one of the poems below.

Birdie, Birdie in the sky,  
I'm an island please stop by.  
The more species that land on me,  
Increase my biodiversity!

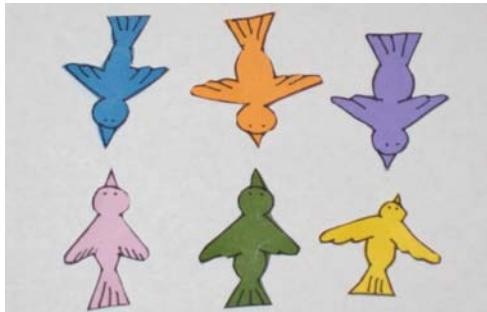
-or-

Hey Mr. Hurricane in the sea,  
When will your winds stop pushing me?  
Let me land on an island please,  
And I'll increase its biodiversity!



Construct a map with five green islands of different sizes inside the bottom of the box. These islands should be cut and glued to a sheet of blue construction paper or drawn directly on the bottom of the box. Be sure to label these islands according to size, “A” through “E.”

Draw six birds, similar to those on the right, to be used in your box. Remember to make each bird a little bit different in size, shape, and color, to represent different species of birds.



## **Quiz**

1. Based on your investigation with the Biodiversity Box and the discussions we had in class, define biodiversity.

*Answer: Species diversity is a common measure of biodiversity and is obtained simply by counting the number of different species in an area.*

2. How does the loss of natural habitats affect biodiversity?

*Answer: It decreases biodiversity because smaller patches of habitat (islands) are smaller targets and thus, fewer species are able to successfully colonize (land on) the habitat.*

3. When it comes to the size of nature reserves, explain how conservationists can increase biodiversity.

*Answer: Since nature reserves are essentially islands of habitat, conservationists can increase biodiversity by making reserves as large as possible.*

4. Why are invasive species such a concern for biodiversity?

*Answer: Invasive species can act as strong competitors or predators of native species. As native species struggle to exist in shrinking habitats, invasive species can be the final straw that causes the loss of species from a local natural area.*

5. How do you think environmental pollution might affect biodiversity?

*Answer: If pollution prevents species from using a portion of their natural habitat, it essentially is contributing to habitat loss and could result in decreased biodiversity.*