Biodiversity Matters

Chicago-Calumet River Classroom Activity

Summary

Students play a game that explores the issue of biodiversity and demonstrates why having a rich variety of life is important to the survival of our ecosystems and how invasive species are threatening local biodiversity.

Grade Level: 6^{th} – 12^{th}

Duration: One class period

Objectives:

1. Students will be able to define biodiversity.
2. Students will be able to distinguish between the terms native, non-native, adventive, invasive, and naturalized.
3. Students will be able to articulate some of the impacts of loss of biodiversity

Materials:

- Small paper cups (2 for each student)
- Beads (or similar objects) in a variety of colors – blue, orange, green, red, yellow and brown (or black)
- Copies of Color Code Key (1 per student)

Standards:

3.B.4a, 3.C.3a, 4.A.3c, 17.B.3b

NGSS:

W.8.1-4, W.12.1-4, SL.8.1a-d, MS-LS2-4, 6.EE.B.7, HSA.REI.B.3

Background

Biodiversity is defined as the variety of all life. It includes all the genes, species and habitats in a given area. Across the world, and right here in the Chicago-Calumet River watershed, we are losing our biodiversity. So why does that matter? Biodiversity is important for a wide variety of reasons.

Biodiversity supports the life systems of the earth, filtering water, cleaning air, and providing protections during storms and flooding. Our food system depends on biodiversity to grow food and other products people use, including from bees that pollinate plants and the bugs and tiny animals that create healthy soil. People also tap into the genetic biodiversity of the world in search of new drugs to cure and treat diseases. . .

Nature offers us a wealth of physical, mental, and emotional health benefits.. . It inspires our creativity and challenges our minds as we try to understand the way the world works. . People also enjoy watching, photographing and exploring the rich species and habitat diversity of the world. . Biodiversity is also intrinsically valuable just because it is there. . We do not have to use it or experience it for it to have value.

Another argument for maintaining biodiversity is that it leads to greater ecosystem resilience and stability. When there are a variety of species that all provide similar functions and one of them disappears the other species can take over and provide the same function.

For instance if 5 different grasses provide food for one type of bird and one of the grasses disappears, the bird is likely to survive because it still has four other grasses it can eat.

Native

- A species that naturally originated and developed in its current habitat. It has evolved alongside other native species, often supporting a wide range of local wildlife.

Non-native

- A species that was introduced to a new area, either intentionally or accidentally, so is not native to that ecosystem. They may be harmless or even beneficial, and their presence does not necessarily harm the ecosystem.

Adventive

- A non-native species that has only a temporary, weak establishment in a new environment. Its populations may not be self-sustaining and depend on a continued supply of new individuals from its native range.

Naturalized

- A non-native species that has successfully established a self-sustaining population in a new environment. It can reproduce and spread without human help. Unlike invasive species, they do not cause significant harm to the native ecosystem.

Invasive

- A non-native species that causes or is likely to cause environmental, economic, or health harm. They spread aggressively, often outcompeting native species and decreasing biodiversity. Their spread is frequently unconstrained by natural predators or climate.

Procedure

Before Class

- Pre-activity to get students familiar with the different plants and animals in this activity and what native, non-native, and invasive animals are.
  - Middle School – cut out the memory cards to play a memory game with the pictures of the plants and animals and then talk about them.
  - High School – assign groups of students to each plant/animal and have them research and present about their plant/animal. You could use the plants/animals in the activity.
  - Native plants and animals
    - Bluegill, Virile crayfish, Dragonfly, Largemouth bass, Blue flag iris, Algae, Sugar maple tree, Willow tree, Belted kingfisher, Osprey, Great blue heron, Fingernail clam, Beaver, Muskrat, Little brown bat, River otter, Spiny soft shelled turtle, Green frog, Painted turtle, Snapping turtle
  - <u>Invasive Species</u>
    - Bighead carp, Buckthorn, Purple loosestrife, Zebra mussel
- Before class, divide out the beads. For each student, place a handful of beads in one cup (with the brown/black ones removed) and about 40 brown/black beads in another cup.

Introduction and Instructions

- Tell students that a major threat today to healthy ecosystems is loss of biodiversity. Today they will be modeling how ecosystems lose biodiversity and exploring some of the consequences.
  - Middle School – Play memory card game. Lay out all of the cards randomly. Students take turns flipping over a pair of cards. If they match the student takes those two cards and is done (have enough cards for each student to get a pair (or group students in pairs). Once done, talk about each plant/animal, whether it is native/invasive, and where it might live.
  - High School - Have the students present about their assigned plant/animal. Include whether it is native/invasive, where it might live, and what efforts have been taken to reintroduce/remove it (if any).
- Pass out the cups of beads to each student (or groups of students) – one with color and one with brown/black.
- Tell the students that the cup of colored beads represents the biodiversity of a healthy river ecosystem. Different colors represent different organisms. Have them look at the color code key that you passed out to understand which colors represent which organisms. Have students pour the beads out onto their desks in front of them.
- Tell students that the brown/black beads represent common river invasive species.
- If you wish to do the statistical analysis of the results at the end of this lesson, have each student/group of students count how many of each color of beads they have to start, and the total number of beads as well. Also have them pour out their beads onto the 3x3 grid and calculate a Sequential Comparison Index (SCI) before they start.
- **How to Calculate SCI:** Start counting beads in one of the 9 sections of the grid. Go from grid to grid counting "runs." A run in this case is a change of color as you go from bead to bead For example, if all the beads are the same color, then you would have only one "run." If every bead is of a different color, then the number of "runs" would equal the number of pieces of candy.
- Have the students look at their color code keys to see what these beads represent. Have students keep these beads in the cup.

Playing the Game

- Read the invasive species scenarios and have the students follow the instructions at their desks. When they are told to remove beads, tell students they should put them in the empty cup.
- If the students are instructed to remove a particular "organism" and do not have any more of that color, tell them to just add what has been instructed to add. It is not necessary to have no native species at the end of the game, there can be a few colored beads left. At the end, each student's pile will be mostly brown or black, with just a few colored pieces left.

Discussing the Results

- What can you say about the colors representing your healthy river ecosystem?
  A lot of colors, very colorful.
- What does the variety of all this colors represent?
  The biodiversity of the healthy river ecosystem.
- What can you say about the appearance of the colors after the invasive species had come into the ecosystem?
  It became mostly darker and drab.
- What does this change to mostly brown or black represent?
  A loss of biodiversity.
- Which ecosystem would you rather visit, the colorful or the drab one?
  Though this is a matter of opinion, I would rather visit the colorful one because there would be more interesting things to see.
- Which ecosystem do you think animals would rather visit because they could find more of what they need there?
  The colorful one because there are more choices. In addition, since invasive species come from different parts of the world, they often are not tasty to local animals and are not as useful to them for shelter.
- You are familiar with food chains and food webs. How does the presence of invasive species disrupt a healthy food web?
  As native species are displaced by invasive species, other species that depend on them are also affected and lost from the web. Because so many organisms in a food web are connected to each other, disrupting some can cause the collapse of the whole thing.

Statistical Analysis of the Results

- Have your students count how many of each different color beads they had at the beginning and then have them do the same at the end (or if you're really into it – after each step of the scenarios is read). Have them do the following calculations for diversity:

- **Simpson Index of Diversity: $D = 1 - \sum (n/N)^2$**
  Where n= number of organisms of a particular species (color) and N = total number of organisms.

- **Sequential Comparison Index (SCI)**
  Have your students pour out their candy onto the sheet that is divided into nine sections. Have them pick a random square to begin. Count "runs" of the candy based on color in that square from left to right (i.e. a run is a string of candy the same color. If two consecutive candies are the same color, they are in the same "run". If they are different colors, begin a new "run".) Proceed through the entire sheet until they return to the candy they started with.

  Where SCI= number of "runs" (colors) in a population/total number of organisms.

- **Diversity Index: DI = SCI** (Sequential Comparison Index) **x TR** (Taxa Richness)

  Where SCI= number of "runs" (colors) in a population/total number of organisms.
  Where TR= number of distinct species in the population.

Reflection

Have students create a pamphlet showing the importance of biodiversity to the river and its watershed and what problems might be associated with a loss of variety. Tell the students to design this pamphlet in a way that would convince any person off the street of the importance of biodiversity.

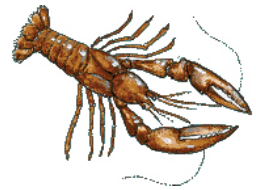
Simpson's Index of Diversity

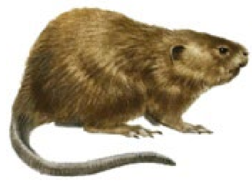
0 = No Diversity **1.0= Infinite Diversity**

SCI Value	
Excellent	0.9-1.0
Good	0.6-0.89
Fair	0.3-0.59
Poor	0.0-0.29

Diversity Index	
Good	12-24
Fair	8-12
Poor	0-8

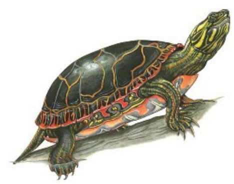




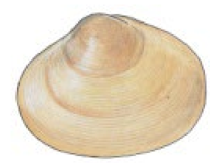



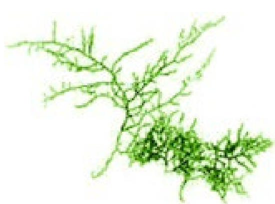


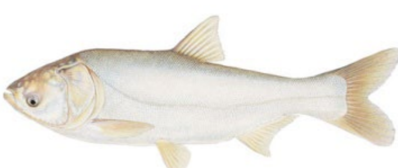










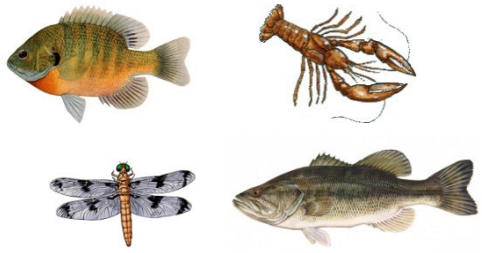




Biodiversity Matters
Color Code Key

Fish and Insects (BLUE Beads)

Bluegill, Virile crayfish,

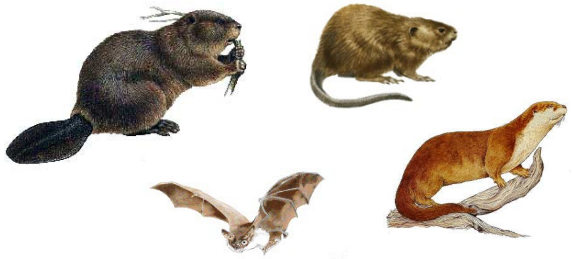
Dragonfly & Largemouth bass



Mammals (ORANGE Beads)

Beaver, Muskrat,

Little brown bat & River otter



Native Plants (GREEN Beads)

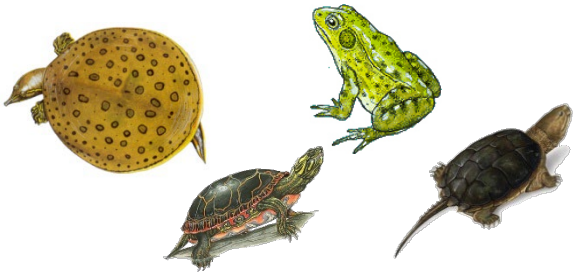
Blue flag iris, Algae,

Sugar maple tree & Willow tree

Reptiles and Amphibians (RED Beads)

Spiny soft shelled turtle, Green frog,

Painted turtle & Snapping turtle



Birds and Clams (YELLOW Beads)

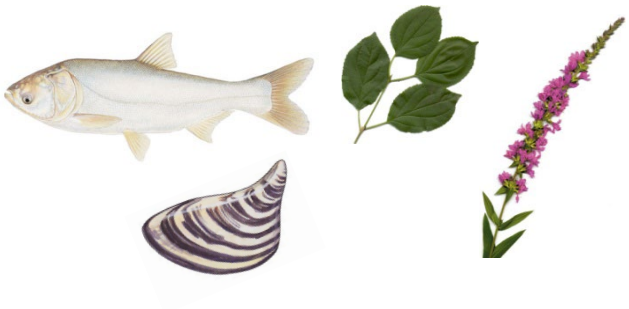
Belted kingfisher, Great blue heron

Osprey & Fingernail clam

Invasive Species (BROWN/BLACK Beads)

Bighead carp, Zebra mussel,

Buckthorn & Purple loosestrife



Biodiversity Matters
Invasive Species Scenarios

- Purple loosestrife moves in! Replace two blue flag iris and one willow with three purple loosestrife. Blue flag iris can't come up through the purple loosestrife, and new willow seedlings cannot grow on the banks as the purple loosestrife takes all the nutrients and block the sunlight.

- Bighead carp moves in! Replace two largemouth bass,two bluegillwith four Bighead carp. The carp are multiplying. Carp feed by digging in the soil at the bottom of the river. They toss up so much dirt that the water gets very cloudy, so other species have trouble seeing and finding food. Remove two crayfish and one osprey.

- Zebra mussels move in! Replace three algae,two fingernail clams and one crayfish with five zebra mussels. The zebra mussels are becoming so great in number that they are filter- eating large amounts of algae and taking habitat from other clams.

- Buckthorn moves in! Replace one willow, two sugar maples, and one beaver with four buckthorn. New willow seedlings cannot grow as the buckthorn takes all the nutrients and blocks the sunlight, and beavers have no more large trees to make dams with.

- Restoration ecologists are able to remove some purple loosestrife. Take out two purple loosestrife and replace them with one willow and one maple. A few seedlings were able to take root.

- Bighead carp multiply! Remove two blue flag iris and two dragonflies. Add two Bighead carp. The carp have pulled up the roots of the irises while foraging for food and have eaten some dragonfly nymphs.

- Some Bighead carp have died from a disease. Replace two Bighead carp with one bluegill, one crayfish and one dragonfly nymph.

- Buckthorn multiplies! The city has cut down a few diseased trees leaving plenty of bare open space. The buckthorn takes over this space. Remove two sugar maples and two willows, and add five buckthorn. Beavers have few trees to eat, so they choose to move on. Remove two beavers.

Biodiversity Matters
Invasive Species Scenarios

- The sugar maples, willows and blue flag irises have been outcompeted by buckthorn and other invasive species. Muskrats have few native plants to use to build their aboveground homes and to eat and bats have fewer trees in which to seek shelter. Add three buckthorn and remove two muskrats and two bats.

- Volunteers have been hard at work releasing special beetles that eat purple loosestrife. Some of the plants die. Remove two purple loosestrife and replace them with two blue flag irises.

- Zebra mussels multiply! Someone collected them from Lake Michigan and decided that they didn't want them in their fish tank after all, so they dumped them in the river. The mussels are eating a lot of algae. Remove three fingernail clams and three algae, and add five zebra mussels.

- Bighead carp multiplies! Someone had a bunch of carp in a backyard pond and decided to take out the pond. They threw the carp into the river. The carp are clouding up the water, so remove two bluegills, three largemouth bass and add three carp. The carp have also eaten some dragonfly nymphs, remove three dragonfly nymphs and replace them with three carp.

- The amount of dragonfly nymphs in this area of the river is low. Therefore, there isn't much for green frogs and painted turtles to eat. Remove four green frogs and one painted turtle.

- Native fish and frogs are becoming rare in this area of the river as more invasive species move in. With fewer fish and frogs to eat, Great blue herons, osprey and belted kingfishers decide to go to another area to look for food. Remove two great blue herons, one osprey and two belted kingfishers.

- Native fish and frogs are becoming rare in this area of the river as more invasive species move in. The food supply for spiny soft shelled turtles, snapping turtles and river otters is getting low. Remove two spiny soft shelled turtles, two snapping turtles and three river otters.

Biodiversity Matters
Extension: Restoration Scenarios

- Restoration ecologists and volunteers conduct a restoration workday at a wetland site near the river. Replace three purple loosestrife with two blue flag iris and one willow sapling.

- Research into keeping the Bighead carp out of the river progresses. Scientists place an electronic barrier that keeps them out! Replace five Bighead carp with two largemouth bass and two bluegill. There is now more available food for other species. Add two crayfish and two osprey.

- Zebra mussels like to congregate around outflow pipes. These have been located and mapped by scientists. Entire colonies of zebra mussels are able to be removed – others are eaten by fish. Replace five zebra mussels with three algae, two fingernail clams and one crayfish.

- Buckthorn used to make up 40% of our forest preserves. Because of the hard work of restoration stewards and volunteers with saws and lopers some of the buckthorn is beiong cut down and burned. Replace five buckthorn with one willow and three sugar maples. These grow along the river and provide homes for some animals. Add one beaver and 3 bats.

- Painted turtles and snapping turtles can now access upland nesting sites because of buckthorn removal. Add two baby painted turtles and one baby snapping turtle.

- Some Bighead carp have been eaten by the returning osprey. Replace four Bighead carp with two osprey, one bluegill, one crayfish and one dragonfly nymph.

- The amount of dragonfly nymphs in the river is rebounding. There is now more for green frogs, painted turtles and bats to eat. Add four green frogs, one painted turtle and three bats.

- Native fish and frogs are becoming more common in the river as more invasive species are removed. With more fish and frogs to eat, Great blue herons, osprey and belted kingfishers decide to nest next to the river. Add two great blue herons, one osprey and two belted kingfishers.