Title

Biological Magnification

Overview

This lesson is used to illustrate a concept that is hard for many students to grasp. In the same way that a teacher would use a diagram, demonstration, photo, or video to supplement a verbal explanation, this simulation incorporates students as components of a model to bring an abstract concept to light. By moving around the room and observing the simulation from the inside and out, students are fully engaged in this lesson. Furthermore, students collect, graph, and analyze data from the simulation, supporting their explanations using a mathematical representation as required by the Next Generation Science Standards (NGSS).

Objectives

- Students understand that persistent pollutants bioaccumulate in the tissues of an organism over its lifetime.
- Students understand that the concentration of bioaccumulated pollutants increases at higher trophic levels, and this is called biological magnification.
- Students understand that the top predators in an ecosystem are most at risk from the effects of persistent pollutants.
- Students know that bald eagles and other predatory birds were affected by magnified levels of the pesticide DDT, and their numbers reached drastic lows before the chemical was banned.

NGSS

- HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Key Terms

- Persistent- Continuing to exist over a long period of time
- Biomagnification- The increasing concentration of a substance in the tissue of an organism at successively higher level of the food chain.
- Bioaccumulation-The accumulation of substances in the tissue of an organism over time

Materials (per student)

- Organism ID tag
- Small container (1-cup or 2-cup size) - no lid

Materials (per class)

- 10 larger containers of various sizes (1-quart to 4 quarts) – no lids
- 3 boxes of mostaccioli pasta

Preparation/Class set-up

- Projector should be turned on and PowerPoint presentation ready prior to class.
- Student seating is unimportant since students will be moving around room, but table arrangement should allow for ease of movement between and around tables.
- It is important to count the number of participants before starting this activity. Make sure the ratio of trophic levels used resembles a pyramid. For a group of 30, for example, use the fisherperson and the bald eagle, 3 large fish, 5 small fish, 8 zooplankton, and 12 phytoplankton. Set aside any ID tags you won't be using.
- Have all the pasta distributed evenly in 4-5 of your largest containers. After the PPT introduction and at the beginning of the simulation, ask 4-5 student volunteers to carry the containers around the room, spreading the pasta evenly around on the table/desk tops.

Activities

- Teachers Shows PPT entitled Biomagnification and discusses the movement of toxins through the food web (first 3 slides). The following is a script of this lesson:

Which species in an ecosystem are most at risk of the effects of persistent toxins? Let's do an activity to answer this question.

Each of you is going to play the role of an organism in a Mississippi River ecosystem. You will receive a name tag." (Pass out one name tag and one small container to each student.) *"At the bottom of the ecological pyramid are phytoplankton. Raise your hand if you are phytoplankton. Why are they at the bottom? As producers, they capture all the energy available to the ecosystem, so they support the food web. There is also a greater amount of phytoplankton than any other group of organisms. Next are the zooplankton, then small fish, then large fish, then top predators like the bald eagle.*

If you have an asterisk next to your name, then that means you spend all or most of your time in water, so any pollution that is in the water can be absorbed right into your cells and tissues through the cell membranes in your gills, skin, mouth, etc.

Anytime you hear the world "Noodles," you must stop what you are doing and pick up 1 piece of your pasta from the nearest table and add it to your cup.

Pollution will be represented by pasta, so don't tell the students until after the activity.

Keep the noodles and add it to any other noodles you have already picked up. Each of you has a little container to hold your noodles.

Only organisms that have an asterisk next to their name will pick the noodles up from the table. If you don't have an asterisk, that means you spend all or most of your time on land or in the air, and are not in constant contact with the water, like the fisherperson or the bald eagle. When you hear the word "noodles," do NOT pick up a noodle. Raise your hand if you have an asterisk next to your name. Hands down. Raise your hand if you do not have an asterisk. You're safe, right?

Look at the bottom of your card. It has a list of the types of organisms you consume for energy. In this activity, you will be eating each other. If someone eats you, your entire body would get ingested, and that includes all the noodles you carry in your tissues. Give the predator that eats you your noodles. They will add your noodles to the noodles they are already carrying. You are now dead, but you immediately regenerate. Remember, each time you hear the word "noodles," stop what you're doing and pick up another noodle from the table. As long as you have not yet been eaten and are still alive, find another organism to eat, take its noodles, and move on to another organism.

Now each of you has a container in which to hold your noodles. If at any time your container becomes too small, just come up here and get a larger container to hold your noodles."

Are you ready? Okay, stand up and go ahead and start moving around in your ecosystem…"

Teacher says "Noodles" every few seconds, reminding students to feed on each other and regenerate once they are dead.

- Data can be collected in any number of ways during this simulation. Possible variables to monitor include time, age of individual, trophic level, and noodles accumulated. The teacher may decide to pause the simulation at random time(s) and have students record data as a group on the board (1-3 times) throughout the simulation or have each student keep their own data sheet and record data more often (10 or more times).
- (Once most or all noodles are gone from the tables and top predators have accumulated most of them, tell everyone to have a seat.)

Can I have the bald eagle come to the front of the room? Please bring your noodles with you. What do you notice? The noodles actually represent pollution, and it has bioaccumulated in the bald eagle. Why? The bald eagle is a top predator. When it feeds on its prey, it is gaining not only the pollution that its prey picked up from the water, but all the pollution its prey ingested when it fed on its prey, and when its prey's prey fed on its prey, etc. all the way down to the producers. When a predator eats its prey, it eats all its bioaccumulated pollution too. This means that the higher up you go in a food chain, the accumulated pollution levels are higher too. This is called biomagnification.

Assessment

- Students can calculate means and use graphical representations of data to show that lower trophic levels accumulate less pollution while higher trophic levels accumulate more.

- Students research the effect of DDT on bald eagles and other predatory birds and describe the efforts made to help their populations recover.

Extension

A live raptor presentation is a wonderful supplement to this class, as students can relate what they have learned to a live specimen.