KIDS ENVIRONMENTAL LESSON PLANS

This lesson plan developed by:

Estuaries, Densities and Eutrophication

Overview:
An activity that demonstrates the density differences between fresh and salt water, what an estuary is and how eutrophication happens and impacts the ecosystem.

Ocean Literacy Principles:

1. The Earth has one big ocean with many features
5. The ocean supports a great diversity of life and ecosystems
6. The ocean and humans are inextricably interconnected
7. The ocean is largely unexplored

Key Concepts:

- Understanding the difference in density of salt water and fresh water and how the salt front contributes to productivity in estuaries
- Defining eutrophication: what causes it and how it affects the estuary ecosystem
- Identify sources of pollution, both point and non-point, that increase the amount of nutrients in the estuary
- Understanding algal blooms

Materials:

Per student (or small group of students):

- 2 small wide-mouthed jars or plastic tumblers (8oz peanut butter jars work well)
- 1 medicine dropper
- 1 paper cup of ground pepper

Educator should have the following on hand:

- 1-2 quarts of fresh water

- 1-2 quarts of colored salt water - "ocean water" - prepared using the following:
  - 1-2 quart jars (mayonnaise jars or juice bottles)
  - 1 cup of salt per quart of water (pickling or kosher salt work best)
  - 20 drops of food coloring per quart of water (red is best)
- 1 bottle of algae (green food coloring)

Set-up Prior to Activity:
The "ocean water" can be prepared ahead of time, however mixing it in front of the group effectively engages the student.

Duration:
30-60 minutes

Physical Activity:
Low

Background:
The different densities of salt water and fresh water in an estuary contribute to making very productive environments, and because of an estuary's tendency to "trap" nutrients in the salt front, can become too productive.

Eutrophication affects many of our nations estuaries, leading to an increased rate of algal blooms. The blooms can have negative effects on habitats, by creating hypoxic conditions and reducing the photic zone. Seagrasses and other vascular plants struggle due to their reduced ability to photosynthesize and further contribute to the hypoxic condition. Some blooms occur in species of algae containing toxins, such as domoic acid, which can cause mass fish and mammal deaths, and can lead to poisonings in humans who eat those fish.

Point and non-point source pollution that cause the excess of nutrients are sometimes referred to as cultural or anthropogenic eutrophication.

Activity:
Part One:

1. Discuss the definition of an estuary, and ask students to name the sources of the salt water and fresh water in a local estuary (i.e. the Atlantic Ocean and rain or snow falling in the Hudson River's watershed). Explain that this activity will explore how salt and fresh water behave when they meet in an estuary, and have the students hypothesize about what will happen when they meet. Mix salt water during this discussion.
2. Point out the salt water and fresh water, and then fill their containers one- third full of each. Instruct the students to create an estuary by using the medicine dropper to gently add colored salt water to the clear fresh water. When doing this, place the point of the dropper under the surface of the fresh water and squeeze the salt water out SLOWLY. Add all the salt water to the fresh, without stirring or swirling the mixture. It may be helpful to

place a white card behind the jar to better see what is happening.

3. After the students have created their salt fronts, have them hypothesize about what will happen when nutrients (pepper) are deposited in their estuaries. Next, have them add a pinch of pepper to the estuary and watch what happens for several minutes. If needed, they may gently tap the edges of the jar or push the pepper below the surface with their fingers.
4. If they were successful in creating a salt front, they should see that some particles move slower through the salt water and some became suspended in or on the denser saltwater layer.
5. Next ask them to predict what will happen when excess nutrients enter the estuary and begin part 2, you may want to interject here with the part 1 discussion.

Part Two

1. Hopefully the salt fronts created by the students are still intact, if not, you can quickly make another estuary that all students will use.
2. Designate each student (or group of students) as either a point or non-point source of pollution. Have the students, with their pepper cups in hand, come up with an example of whichever pollution they are, and walk around depositing a pinch of nutrients in each estuary (or newly constructed estuary). As they are polluting estuaries, ask what will happen to algae exposed to an excess of nutrients in the water.
3. Discuss algal blooms as you walk around to each estuary, dropping a few drops of green food coloring into the estuaries. Continue adding more and more food coloring to show more and more algal growth. The green food coloring is symbolic and represents the excessive growth of algae. Have students speculate on what might happen to the estuary habitat as more and more algae grow.

Discussion:

Discuss the relevance of the salt front and primary production in an estuary. Algae, like all plants, need nutrients and light to photosynthesize and grow. If the nutrients were to sink to the bottom, there would not be enough light to support algal life. The trapping effect of the salt front keeps these nutrients at shallower depths where there is plenty of light.

Estuaries are known to be some of the most productive ecosystems, on par with tropical rain forests. Many marine species have life cycles adapted to take advantage of this productivity, and humans in turn take advantage of it through fishing. Roughly two-thirds of commercially caught finfish and ninety percent of shellfish catch are dependent on estuaries.

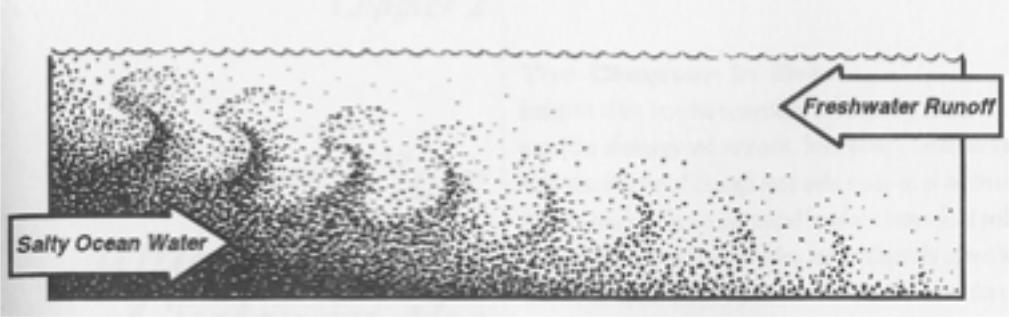
Aside from fishing, ask the students to think of other ways humans affect watersheds and their estuary ecosystems. Hopefully someone will mention pollution, take that opportunity to explain point and non-point pollution. Invite the students to come up with examples of each. Be sure to mention fertilizer runoff and sewage treatment plant runoff, as these are examples that result in an excess amount of nitrogen and phosphorous. Explain the difference between naturally occurring eutrophication and cultural or anthropogenic eutrophication.

Estuaries, Densities, Eutrophication (cont.)

Discuss how algal blooms affect vascular plants by creating hypoxic conditions and reducing the photic zone. Hypoxia occurs when the blooms of algae die off and are decomposed by bacteria. Reduction of the photic zone also contributes to hypoxia, by handicapping the ability of vascular plants, like seagrasses to photosynthesize.

Algal blooms also affect fish and mammals, including humans. Some species of algae contain toxins, such as domoic acid, that can lead to the death of the organisms that eat them and shellfish poisoning in humans. These are referred to as Harmful Algal Blooms or HABs.

Talk about how point source and non-point source pollution contribute to algal blooms and things that we can all do to reduce the amount of nitrogen and phosphorous. Invite the students to investigate the products they use in their households, such as bathroom cleaners and lawn fertilizers to see if they contain these nutrients. Have the students think about potential solutions for anthropogenic eutrophication and what they can do themselves to minimize the enrichment of nutrients in a local estuary.



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