Subject: Science, Social Studies

Grades: 8-12

Duration: 45-minute class period

Lake Water Quality

Lesson Overview

Students will be introduced to the concept of trophic states (oligotrophic, mesotrophic, and eutrophic) and point vs. nonpoint pollutant sources. They will then use a simulator (the Lake Water Quality Simulator) to change certain parameters relating to those sources and see how they affect overall water quality and trophic state. They will also change BMP's (best management practices) to improve the water quality and return to a more stable trophic state.

Objectives

By the end of the lesson, students should be able to:

- define trophic state
- identify the three trophic states (oligotrophic, mesotrophic, eutrophic)
- define point and nonpoint pollutant sources
- use BMP's to improve water quality

Introduction

Begin the lesson with an introduction to algae and the concept of trophic states.

Why are some lakes green? (algae, mud, etc.)

Lakes can be green for several reasons. Typically, lakes are green because of green algae growth. Algae is very important to the health of lakes, because they are at the bottom of the food chain and supply food to other important species. If there is too much, however, the lake can become polluted and unfit for human consumption. Blue-green algae (which is actually a species of bacteria) can also grow in lakes that are rich with nutrients. This can happen rapidly in events called 'algal blooms', in which the lake is overcome with massive amounts of algae. Blue-green algae can be harmful if they are toxic, or if the bloom is especially large.

While some lakes are murky and green, others are clear as crystal. Why do you think this is? (no algae, cleaner, etc.)

Lakes are clear when there are few nutrients present. This is ideal for drinking purposes, but for a lake meant to support life like fish and other animals, this is usually a sign of an unhealthy state. The key to supporting a healthy, unpolluted lake is to find a balance between the two.

There is a term for types of lakes depending on how nutrient-rich and life-rich they are, and they are called trophic states. Oligotrophic, coming from the Latin oligo- *meaning 'few', is used to describe the clear lakes we were just talking about. Nutrient-rich lakes which are full of life are called eutrophic, and lakes that fall in between these two states are called mesotrophic. These three trophic states are used to classify the water quality of lakes based on how nutrient-rich they are.*

At this point, have the students pull up the Lake Water Quality Simulator.

How do you think nutrients get into lakes?

Nutrients come from different land uses that are detailed on this map. They can come from industrial and residential sources, as well as wastewater. However, they primarily come from rural areas, due to runoff of pesticides containing nutrients like phosphorus and nitrogen. Phosphorus and nitrogen (mostly phosphorus) are the main two nutrients that contribute to algae growth and eutrophication (when a lake becomes eutrophic through an increase in nutrients).

Sources of phosphorus that are direct, like a wastewater treatment plant discharging directly into the lake, are called 'point sources', and indirect sources like agricultural runoff are called 'nonpoint sources'. Today, we'll be using this water quality simulator to see the effects of point and nonpoint sources of phosphorus on a lake's trophic state.

Procedure

1. Explain the Secchi disk transparency test, and have the students increase the phosphorus concentration in the waste water plant point source to see how increased phosphorus effects the Secchi disk test.
2. Have the students experiment with the low-slope and high-slope land use module. Ask questions like: "How does slope affect the inflow of nutrients to the lake?" "What types of land use affect the inflow of nutrients?" Have them set the forest and pasture to 0% and the cropland to 100%.
3. Keep the BMPs unchecked. At this point, the lake will be as eutrophic as possible. Challenge the students to use the BMPs and the low-slope and high-slope land uses to improve the quality of the lake.

Conclusions

After the students experiment with the different parameters and improve water quality, recap some of the main concepts:

What was the initial trophic state of the lake? (eutrophic)

What was the final trophic state of the lake? (oligotrophic or mesotrophic)

Using best management practices, we improved the water quality of the lake by decreasing the concentration of phosphorus in the lake. The negative effects of point sources (like the wastewater plant) and nonpoint sources (like rural agricultural runoff) were reduced.