WATER QUALITY

Effect of nutrients on water sources

Focus questions	What is the effect of added nutrients on water sources? What is the source of these added nutrients?
Learning target	Students will investigate the effects of nutrients on water quality.
Vocabulary	Runoff, submerged aquatic plants, dissolved oxygen, decomposition, hypoxic

MS-LS2: Ecosystems: Interaction, Energy, Dynamics

Performance expectation MS-LS2-1	**Classroom connection:** Students will investigate the effect of known quantities of nutrients on a water source.

Science and engineering practices

Analyzing and interpreting data	**Classroom connection:** Students will model an aquatic ecosystem; add nutrients in known quantities, then determine what happens to the ecosystem. Students will analyze their experimental data, then brainstorm ideas to prevent nutrients from being added to waterways.

Disciplinary core ideas

LS2.A: Interdependent Relationships in Ecosystems	**Classroom connection:** Students will investigate a natural aquatic ecosystem and the effects of added nutrients on that ecosystem.

Cross-cutting concepts

Cause and Effect	**Classroom connection:** Students investigate the amounts of nutrients and the effects of those nutrients on algae growth in natural water systems.
Stability and Change	**Classroom connection:** Students investigate the causes of eutrophication and how it affects the stability of an aquatic ecosystem.

This activity asks students to analyze data from an investigation to determine the effects of limited resources (added nutrients) on the ecosystem.

Background

Phosphorus and nitrogen are limiting factors in waterways. If they are not present in large quantities, the ecosystem will stay in balance. The algae that is naturally present is kept in check by a lack of these nutrients. When these nutrients increase, it can result in an algal bloom. As the algae increases, waters become less clear, which can block sunlight to submerged aquatic plants, causing them to revert to cellular respiration to obtain energy. This requires oxygen, and makes less oxygen available to other organisms as result. Competition increases between the algae for decreasing oxygen amounts, and eventually they begin to die. The process of decomposition also requires oxygen, causing the dissolved oxygen level to fall further. This can result in massive fish kills. The massive mats of algae can also make these bodies of water unappealing for recreation. If toxins are present, the water can be dangerous to swim in or drink.

Surface water is judged on its quality by using several parameters. The diversity and amount of biotic life and the chemical composition of the water play a role. The amount of **dissolved oxygen** in a body of water is critical to supporting biotic life. Different water dwellers can tolerate different levels of dissolved oxygen. An area in a body of water that has little or no dissolved oxygen is called **hypoxic.**

Fertilizers are an input on farm fields. The nutrients in fertilizer include **nitrogen (N), phosphorus (P),** and **potassium (K).** Different fertilizers include varying amounts of N, P, and K and are used for different crops. Crops need all three nutrients in order to grow and produce seeds. Each serves a specific function in plants, and different plants have different requirements for each nutrient. The effect on water is determined by the salinity level and the plant life. N is a limiting factor in salt water (such as the Gulf of Mexico) and P is the limiting factor for fresh water. A limiting factor determines how much plant growth might occur if there is excess N or P in the water.

How do excess N and P get into water sources? When farmers apply fertilizers to fields, there is a specific amount applied per acre depending on the available nutrients in the soil and the crop that is planted. Those nutrients, if not incorporated into the soil right away, may be washed away by a rainstorm. Even if incorporated, some of those nutrients may be eroded before the plants can utilize them.

In this experiment, inorganic nutrients will be added to water collected from the environment and grown in the classroom under fluorescent lights or by a bright window.

Adapted from: `ei.cornell.edu/watersheds/Eutrophication_Experiments.pdf`

Materials

- Liquid fertilizer with varying amounts of N, P, and K
- Natural water sources
- 250 ml beakers, or other containers

Prior knowledge

Students should have studied nutrients and their roles in the ecosystem and completed soil testing labs. Ideally, they should have studied the nitrogen, phosphorus, and water cycles. If they have not, this activity can give them an opportunity to study these things as they wait for changes in their ecosystems to develop.

Suggested timing

The Effects of Nutrients on Water Sources Lab may take up to two weeks for the algae to grow. Students should make an observation on day 3 and on day 7, then again on day 10 and 14. Time may need to be adjusted for time of year—temperature of the room and light conditions. Advanced students may extend this lab by testing various temperatures and lighting conditions to compare to other more “standard” testing conditions.

Teacher preparation

1. Students may bring in water samples or the teacher can go to a nearby waterway to collect them. Water that already has a good amount of algae will grow faster than water that is more clear. The teacher may also do a demonstration for the students in advance of the lab by having two samples of water for them to observe: one from a hypereutrophic pond and is already quite green and one from a waterway with clearer water.
2. Students may work in groups of four students to take responsibility for one of the four different conditions that will be compared to the control.
3. If teachers have no access to an environmental water source, algae cultures can be purchased from a biological supply company. They can be used to grow large quantities of algae, but this will take time and should be planned for in advance.
4. Algae will grow faster in a warmer environment and if the samples are under the lights for 24 hours a day.
5. Containers with the most fertilizer (8 ml) will show the most growth. The conditions that lead to algae growth in water sources include shallow water and warmer temperatures.

Differentiation

Other ways to connect with students with various needs:

- **Local Community:** Consider having a speaker come to talk to the students about protecting local waterways from run-off, such as a local farmer or someone from the county extension office.
- **Students with special needs (language/reading/auditory/visual):** The students will work in groups on this experiment.
- **Extra support:** Teachers may reach out to local lawn treatment businesses or a farm co-op to find out what practices they use.
- **Extensions:** Students may develop a survey to determine the habits of residents that use lawn chemicals on their yards. Students may create an educational message about the proper use of fertilizers for homeowners. Students can plan their own experiment. Have them consider other variables such as determining if one nutrient in the fertilizer is a limiting factor or if one nutrient contributes more to eutrophication than others. They can work with a local farmer or someone from the county extension on a project in the community.

Assessments

Rubric for assessment

Skill	Developing	Satisfactory	Exemplary
Analyze and interpret data	Student collected quantifiable data.	Student collected quantifiable data. Student noticed a relationship within the set of data.	Student collected quantifiable data. Student noticed a relationship within the set of data. Student can explain the relationship within the data set.

Rubric for self-assessment

Skill	Yes	No	Unsure
I am able to analyze the data collected.			
I am able to see relationships between data collected and variables tested in the lab.			
I am able to explain the relationships between data collected and variables tested in the lab.			