WATER QUALITY AWARENESS IN URBAN ENVIRONMENTS

LESSON 6
Nutrient No-No's

Lesson 6: Nutrient No-No's

Subject Overview: Fresh water streams, rivers, and lakes contain varying amounts of nutrients. These nutrients supply living organisms with the basic materials they need to grow and reproduce. Nitrogen and phosphorus are essential to the growth of aquatic plants which in turn become a food source to other organisms. Excess nitrogen and phosphorus, however, can lead to excess plant growth in water, most notably in the form of algae. Large mats of algae block sunlight from reaching more beneficial photosynthetic organisms just below the water's surface. As algae dies and begins to decompose, oxygen levels in the water decrease as the molecules are utilized in the decomposition process, resulting in less available oxygen for fish and other aquatic organisms. Minimizing the input of excess nutrients from fertilizer applications and landscape clippings reduces the occurrences of algae mats and the negative impact of decomposition.

Nitrogen and phosphorus are essential nutrients for the growth of aquatic and terrestrial plants. Plant growth and appearance can be significantly improved with the addition of these nutrients in the form of fertilizers. Nitrogen is found in environment in a number of different forms with nitrate being the form most available for plants for uptake and utilization for growth. Phosphorus is also available in many forms, but plants utilize the soluble form phosphate. In most dry environments, nitrogen is the limiting nutrient to growth as phosphorus is present at sufficient levels.

Urban environments, through the use of fertilizers, increase the input of soluble nitrate and phosphate into streams and creeks adapted to lower nutrient levels. Algae growth normally limited by the lack of sufficient nitrogen is increased, resulting in algal blooms floating on the surface of creeks, streams, and rivers. Decomposing plant material sinks to the bottom of the water and begins to utilize the oxygen in the water to break down the plant material. Significant decomposition in a lake or river "robs" fish of oxygen resulting in what are called 'fish kills'. Excess algae also reduce the quality of recreational activities such as boating, swimming, and fishing. This process is called eutrophication.

(Western Pennsylvania Conservancy – "To Fertilize or Not To Fertilize")

In order to grow, plants require essential minerals and elements, along with sunlight and water. If the soil doesn't provide enough nutrients for plants to grow, fertilizers may need to be added.

A fertile soil has adequate amounts of the major plant nutrients – nitrogen, phosphorus and potassium; a sufficiency of the micronutrients (sometimes called trace minerals) – zinc, manganese, boron, iron, sulfur, an abundance of organic matter, and humus. To be fertile, the soil must also have a nearly neutral soil pH as well as good structure and drainage.

Nitrogen, phosphorus and potassium can be obtained from natural sources (animal and vegetable matter) or from inorganic fertilizers that are chemically produced.

When you buy fertilizers commercially, most are labeled with a formula that states the percentage of nitrogen, phosphorus and potassium that the preparations contain. The chemical symbols for these three elements are N, P and K respectively, and the elements are referred to by their symbols on fertilizer bags. If a bag of fertilizer says it is "5-10-5," for example, that means that it contains 5 percent N, 10 percent P and 5 percent K. For example, a 100-pound bag of 5-10-5 would supply 5 pounds of nitrogen to your garden, 10 pounds of phosphorous and 5 pounds of potassium. The rest is inert filler. Both organic and inorganic commercial fertilizers are labeled using these initial letters.
Amounts of these elements can vary in fertilizer depending on what you want or need the plant to do.

Nitrogen maintains plants' green color and is largely responsible for good leaf and stem growth. Nitrogen provides a quick boost of energy to a plant just like a candy bar does to us. It is very soluble in water and thus leaches out of the soil quickly. If your plants run out of nitrogen you will see pale foliage and spindly growth.

Phosphorous is especially important to the root development of a plant. It also helps the plant to produce fruit and seeds and resist disease. Root crops and flower bulbs require a lot of phosphorous. It is not highly soluble and can be applied in the fall.

Potassium is essential for plant growth and for resistance to disease. It is highly soluble and leaches out quickly so must be applied from time to time.

Did you know that if you forget which element is P and which is K, you can use a memory device such as "Phosphorus" is P because the word has two P's in it?

Activity Concepts: nutrients, eutrophication, nitrogen cycle

Subject Links: Science: chemistry, ecology

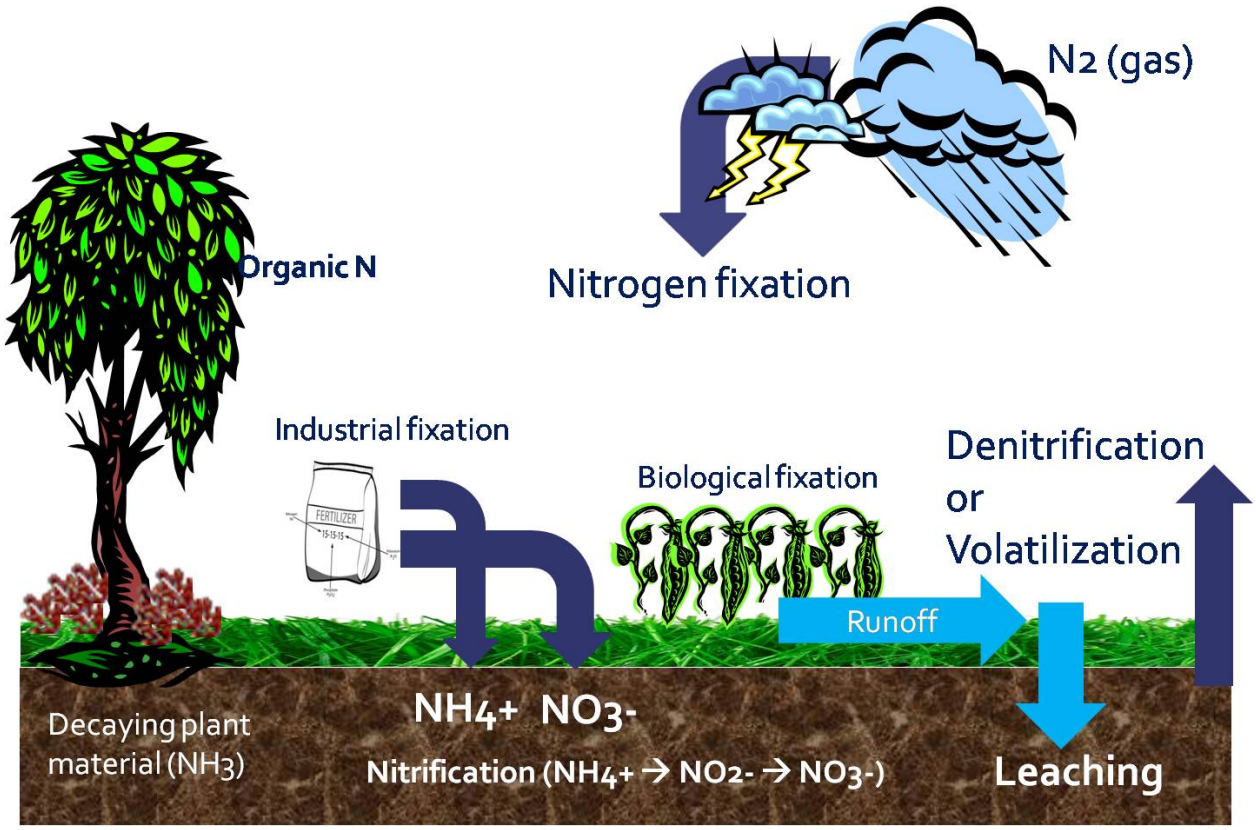
Vocabulary: eutrophication, nitrogen, phosphorus, and decomposition

Purpose of activities: Youth will have the opportunity to learn about the composition of fertilizers and how nutrients (nitrogen and phosphorus) from fertilizers impacts aquatic organisms.

Overview of activities: Youth will explore nutrients through hands-on activities.

Time Required: Approximately 20-30 minutes (Activity 1); approximately 40-50 minutes (Activity 2).

Nitrogen Cycling in the Urban Landscape



Activity #1: Nutrient Math

Experiencing (Procedure):
Using the color/ingredient key, ask the group to appropriately label the jars.
Allow the group 10 – 15 minutes to discuss their answers.
Discuss the need for different rates of fertilizers.

Sharing, Processing, and Generalizing:
Discuss the questions below:
What are the advantages of using organic fertilizers compared to inorganic fertilizers?
Are there any disadvantages to utilizing manures as a fertilizer? If so, explain.

Getting Ready:

- Assign one colored candy to represent each of the following:
  - Nitrogen
  - Phosphorous
  - Potassium
  - Inert Filler
- Apply a blank label to each jar.
- Count out candies; fill and close each jar accordingly:
- 16 – 16 – 16 (Balanced) :
  - 16 – Nitrogen
  - 16 – Phosphorous
  - 16 – Potassium
  - 52 – Inert Filler
- 21 – 0 – 0 (High Nitrogen):
  - 21 – Nitrogen
  - 79 – Inert Filler
- 12 – 55 – 6 (High Phosphorous):
  - 12 – Nitrogen
  - 55 – Phosphorous
  - 6 – Potassium
  - 27 – Inert Filler
- 7 – 3 – 2 (Organic: Cottonseed Meal) :
  - 7 – Nitrogen
  - 3 – Phosphorous
  - 2 – Potassium
  - 88 – Inert Filler

Or

- 1 – 1 – 1 (Organic: Manure):
  - 1 – Nitrogen
  - 1 – Phosphorous
  - 1 – Potassium
  - 97 – Inert Filler

Materials Needed:

- (4) 32oz. Clear Jars with Lids
- 400 pieces each of (4) different colored candies:
  (Example: Red Hots, Lemon Heads, Good and Plenty (colors separated), M&Ms (colors separated), Baked Beans, Mike and Ikes (colors separated), Sugar Babies etc.
- **Printout:** (4) Labels:
  - 16 – 16 – 16 Fertilizer
  - 21 – 0 – 0 Fertilizer
  - 12 – 55 – 6 Fertilizer
  - 7 – 3 – 2 Fertilizer or 1 – 1 – 1 Fertilizer
  - Key for paired color and fertilizer ingredients.

Opening Questions:

Ask the youths to provide their answers on the flip chart paper provided.

- What is a fertilizer?
- What do the numbers on the product bag represent?
- What is the difference between organic and inorganic fertilizers?
- Why is Nitrogen necessary for plant health? Phosphorous? Potassium?
- In what situation might you use a fertilizer with more Nitrogen? Phosphorous?

ACTIVITY #2: Fertilizer Foolishness

Suggested Grouping: Pairs or small groups no larger than 4-6 individuals

Materials Needed per Group:

- Glass bowl slightly larger than 1 quart
- Potable (drinking) water
- Bulk Super Snow (Dunecraft.com or Lakeshore Learning)
- Measuring spoons (1/2 teaspoon and 1 teaspoon)
- Flip chart paper and markers
- **Lesson Handout** - Water Quality Scenario

Getting Ready:

- Fill glass bowl with 1 quart of water representing a lake or pond.
- Provide youth with at least a tablespoon of 'Super Snow' that represents nitrogen and phosphorus fertilizer (algae) and a set of measuring spoons containing ½ teaspoon and 1 teaspoon.
- Green 'Super Snow' can be created by adding food dye to hydrated mixture and then drying in an oven at a low temperature to prevent burning.
- Trash bag to dispose of 'Super Snow' once activity is complete. Material will dry in 4-6 weeks and can be utilized again.

Opening Questions:

1. **Ask youth how they think nutrients are obtained and utilized by plants.** Ask them to explain their thoughts. **Ask them to record their thoughts and ideas on the flip chart paper provided.**

2. **Ask the youth: Why are fertilizers added to lawns and agricultural crops? Where does fertilizer end up if it is not utilized by plants? Ask them to record their thoughts and ideas on the flip chart paper provided. [Facilitator's Tip:** This question is trying to get to the point of water runoff and how it carries nutrients applied to agricultural lands or urban impervious surfaces (sidewalks, driveway, and streets) and landscapes into a body of water.]

Experiencing (Procedure):

Provide each pair/small group with the four scenarios provided below (pp. 8 & 9). Within their groups, ask them to read the scenarios aloud and follow the directions. Ask them to record the amount of 'Super Snow' crystals they add to the glass bowl that represents a lake, pond or bay. Youth should observe and record how the 'Super Snow' would make it difficult for fish to swim, boats to navigate, and other recreational activities.

Sharing, Processing, & Generalizing:

- Ask the youth to use their words to explain what happened in the activity. **Ask them to share the data they recorded and record additional thoughts on the flip chart paper provided.**
- Ask the youth how they think nutrients might affect freshwater animals, marine animals, or estuarine environments (areas where freshwater and marine waters mix). **Ask them to record their thoughts on the flip chart paper provided.**

If necessary, use more targeted questions as prompts to get to specific points. Additional questions might include:

- How can humans to reduce their contribution of nutrients to fresh water stream and creeks?
- Do they think nutrients impact rivers, streams, and the ocean differently at different times of the year?

Concept and Term Introduction:

At this point, facilitators need to ensure that the concepts and terms eutrophication, nitrogen, and phosphorus have been introduced. **Note:** The goal is to have the youth develop these concepts through their exploration and define the terms using their own words.

The facilitator also needs to ensure that:

- The youth understand the concept of eutrophication and how excess nutrients impact waters.
- The youth have identified (from the scenarios) major sources of nutrients in surface runoff.

Concept Application (Optional Activities):

- Take a field trip to a lake, pond, stream, or coastal area. Have the youth observe the different plants and animals. Identify whether the plants growing in the water are invasive or native.
- Have the youth predict how a food web would be affected if the nutrients in a fresh water stream suddenly increased during the rainy season (e.g. impact on insect population, plants, and fish).

Water Quality Scenarios

Scenario 1: You decide your lawn is just not green enough and you hear on the radio that tomorrow it is supposed to rain. You figure today is a good time to fertilize your front yard since the expected rain will water it down into the roots. Unfortunately, the rain is a downpour and your entire lawn floods and much of the fertilizer is carried off into the gutter. **(Add ½ teaspoon of 'Super Snow' fertilizer to glass bowl.)**

Scenario 2: The weather is warming and your grass, trees, and shrubs are starting to put on spring growth so you decide to head to the nursery and pick up a bag of fertilizer to feed your plants. You have an old hand-held spreader that you plan on using to spread the fertilizer. After ripping open the bag you lift it up to pour enough fertilizer into the spreader to fill it up completely, but the fertilizer pours out too quickly and you spill fertilizer all over the driveway. You pick up what you can and put it back into the bag, but granules are small and it is just taking too long. You grab the hose and wash the fertilizer off the driveway in to the gutter since the fertilizer bag warns that it will stain concrete surfaces.cal streams. **(Add 1 teaspoon of 'Super Snow' fertilizer to the glass bowl.)**

Scenario 3: You are a busy person and do not really like to mow and edge the lawn so you hire a gardener. The gardener always does a great job and the neighbors comment on how green and healthy your lawn looks. One day you come home early to see the gardener cleaning up after mowing and edging but he is blowing the clippings down to the street and into the storm drain. **(Add 1 teaspoon of 'Super Snow' fertilizer to glass bowl.)**

Scenario 4: The local sports park near your home is utilized year round for soccer, baseball, and football practice and games so the turf requires a lot of attention by the city landscapers. The turf fields are designed to drain well so that practice and game schedules are not affected by irrigation and rain events. This required the installation of an elaborate landscape drain system that allows runoff to leave the field and enter the storm drain. When the city fertilizes, however, they do not cover these drains and fertilizer falls directly into the drains. **(Add 1/2 teaspoon of 'Super Snow' fertilizer to glass bowl.)**

Resources: