Treatment Plants

Adapted from: "Treatment Plants" in WOW!: The Wonders of Wetlands. Bozeman: The Environmental Concern Inc. and The Watercourse, 1995.

Grade Level: Basic

Duration: 25 minutes

Setting: Classroom

Summary: Students observe how wetland plants take up toxins through a demonstration.

Objectives: Students will understand how wetland plants function to improve water quality.

Related Module Resources:
- "This Plant Key is All Wet" module activity
- The Book of Swamp and Bog
- Plants in Wetlands
- Through the Looking Glass: A Field Guide to Aquatic Plants
- Common Marsh, Underwater & Floating-leaved Plants

Vocabulary: capillary action, cohesion, sequester, assimilate, eutrophication, bioaccumulation

Materials (Included in Module):
- Red food coloring [Book Box]
- Plastic knives [Treatment Plants Module Activity Envelope]

Additional Materials (NOT Included in Module):
- 2 beakers or jars
- Fresh celery stalks with leaves

ACADEMIC STANDARDS (ENVIRONMENT AND ECOLOGY)

7th Grade
4.1.7.B Understand the role of the watershed.
- Explain factors that affect water quality and flow through a watershed.

4.1.7.D Explain and describe characteristics of a wetland.
- Identify specific characteristics of wetland plants and soils.
- Describe the different functions of a wetland.

4.1.7.E Describe the impact of watersheds and wetlands on people.
- Explain the impact of watersheds and wetlands in flood control, wildlife habitats and pollution abatement.

10th Grade
4.1.10.B Explain the relationship among landforms, vegetation and the amount and speed of water.
- Explain how vegetation affects storm water runoff.

4.1.10.D Describe the multiple functions of wetlands.
- Explain how a wetland influences water quality, wildlife and water retention.

12th Grade
4.1.10.E Evaluate the trade-offs, costs and benefits of conserving watersheds and wetlands.
- Evaluate the effects of human activities on watersheds and wetlands.

BACKGROUND:

Wetland plants perform some very important functions to improve water quality. Because wetlands often drain into streams, lakes and other water bodies, the effects they have to remove pollutants from the water are far-reaching. Some of the pollutants that can be removed from water by wetlands are heavy metals, excess nutrients like nitrogen and phosphorus, and petroleum products. Wetlands are even used in some places as part of a water treatment program.

The movement of water through a wetland is generally slow. Because of this, sediment (and any chemicals bound to it) often settles in wetlands. Sometimes, bacteria and other microbes act on pollutants in wetland sediment, transforming them into harmless substances. Moreover, anything larger than sediment is also stopped, not only by the slow movement, but also by the wetland plants themselves. Wetland plants can act to strain larger items from the water being released from the wetland. If large amounts of pollutants are introduced to a wetland, they are often released very slowly. Indeed, often the harmful effects they would have had if added directly to a water body are severely diminished.

Wetland plants draw nutrients up through their roots with water. This is done through a process called **capillary action**, which is a force that makes liquid stick to the walls of a thin tube. Water molecules stick to each other through hydrogen bonds. This is tendency of water molecules is a property called **cohesion**. The cohesive property of water is especially noticeable at the surface, where it causes surface tension. Moreover, water molecules can also stick to molecules of other substances that contain oxygen. For example, think of a glass of water: if you look at it from the side, you will see that the water curves up at the edges. This curving is due to the interaction between water molecules and the molecules of the side of the container. These interactions are hydrogen bonds that pull the water up because of surface tension. If the container is thin enough, like the tubes within a plant, the water molecules are able to keep moving up the sides. This movement is capillary action and it is this action that enables wetland plants to **sequester** (or take up) nutrients and other substances dissolved in water.

Excess nutrients can be used by the wetland plants for maintenance, growth and reproduction and **assimilated** (or incorporated) into wetland plant tissues. By removing these substances from the wetland water, wetland plants prevent the nutrients from being released into waterways where they could cause eutrophication. **Eutrophication** is the addition of excess nutrients to a water body. It often results in algal blooms, which can use up great amounts of oxygen (when the algae die and are decomposed). Without dissolved oxygen in the water, many aquatic organisms must move elsewhere or die.

In addition to nutrients, wetland plants can also take up toxic compounds from the sediments. These toxins are incorporated into the tissues of the plants, where they remain until the plant dies and they are released again into the water or sediment. Although many toxins bind to wetland sediments or are taken up by other wetland plants, some toxic compounds inevitably pass through wetlands to be released into other water bodies.

Although wetlands can sequester nutrients (often preventing eutrophication) and can take up other toxins (temporarily removing them from the water) it is important to note that wetlands cannot solve all of our water pollution problems. Sometimes wetlands are so overloaded with nutrients that algal blooms occur. Moreover, even if toxins are bound up in plants, they have not disappeared. Organisms that eat these plants can accumulate the toxins in their bodies as well. These organisms might die because of toxic overload. Consumption of organisms that have eaten the contaminated wetland plants by other organisms could eventually lead to **bioaccumulation**, or the accumulation of toxins in organisms higher in the food chain. This could even affect humans who are at the top of the food chain. Indeed, wetlands are not a panacea for all of our water pollution ills; nonetheless, without wetlands, water bodies would be significantly more polluted and water quality in general would be dramatically lower.

OVERVIEW: Students observe how wetland plants filter water through a demonstration using celery and food coloring.

PROCEDURE:

Teacher Preparation:

1. Purchase celery at your local grocery store.

2. **THE DAY BEFORE THE ACTIVITY**, add several drops of food coloring to a water-filled beaker or jar. Cut off the bottom half-inch of the celery stalks and place the stalks in the colored water overnight.

Student Activity:

1. In class, explain the procedure if the students were not present when Step 1 was done. Tell the students that the food colored water represents water polluted with a toxic substance such as a pesticide. Let the students suggest other toxic substances.

2. Ask the students to imagine that the water is flowing through a wetland and that the celery stalks are the many plants growing there (cattails, sedges, grasses, etc.).

3. The colored water should have traveled up the stalks overnight, via capillary action. This illustrates how plants can absorb pollutants with the water they "drink."

4. The colored water may or may not be visible on the outside of the stalk. Cut off 1-inch pieces of the celery and hand them out for students to study closely. Colored dots should be seen on the cut surface. Explain that these are vertical, water-filled channels in the celery seen in cross section.

5. You may elect to have students start some new celery stalks and watch them over the next few days.

DISCUSSION:

Talk to the students about what happens to pollutants when they pass through a wetland. How do wetland plants help purify water? *See the Background section.*

Why is the water remaining in the beaker/jar still polluted? Where does the water go after uptake into the plant? What happens to the pollutants? Do they disappear completely? *See the Background section.*

What might we do in order to remove the pollutants completely from the wetland ecosystem? *Plants that have taken up the pollutants could be harvested and removed from the site.*

Why can't we dump all of our waste into wetlands? *See the Background section.*

What would happen to water quality if we destroyed wetlands? Why? *See the Background section.*

EVALUATION:

- Describe how wetland plants improve water quality.
- Explain what happens to toxins that enter a wetland.
- Describe capillary action and cohesion.

EXTENSIONS AND MODIFICATIONS:

- Find a stormwater management pond nearby. This is a place that was built to filter polluted runoff and excess rainwater from construction sites, streets and communities. Visit the pond on a dry day and again just after a heavy rain. Observe the differences between water washing into the pond, water in the pond and water leaving the pond. Where is the water coming from and where is it going?
- Research how wetlands are used in wastewater treatment in the U.S. and elsewhere in the world.
- Research the processes by which wetland plants convert toxins into less noxious forms.
- Research which wetland plants best sequester nutrients and transform toxins.
- Conduct water quality analyses (chemical, biological) of water entering a wetland and compare it to the quality of water leaving the wetland.

NOTES (TEACHERS, PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):

Activity Version: June 2003