TOO MUCH OF A GOOD THING ACTIVITY 4

**Objective:**

Students will learn what an estuary is and explain how it functions in a watershed.

Students will describe how upstream activities can contribute to nonpoint source pollution and nutrient loading in an estuary.

Students will conduct an experiment on nutrient loading and undertake a water runoff audit on campus.

**Materials:**

Copy of handout one for each student

Copy of handout two for each student

Copy of handout three for each student

Classroom set of scissors

Large map of United States

Per lab group: four glass or clear plastic jars; water from a local pond, creek, or aquarium; liquid or granule fertilizer; optional water quality test kit

**Teacher Prep Notes:**

This activity requires collecting water from a local waterway or aquarium to supply each lab group with enough water to fill four jars.

It also requires supervising students as they conduct a water runoff audit on campus plus requesting the cooperation of maintenance staff for a student-led interview.

**Background:**

An estuary forms where a river meets the sea. Fresh water flowing downstream mixes with salt water flowing in with the tides. In this highly dynamic system, biological productivity is high. So too is the system’s vulnerability. Activities that occur in the river’s watershed influence the health of the river and in turn, the health of the estuary.

For example, eutrophication is a natural process that can be accelerated by human activity. A eutrophic body of water is nutrient-rich, marked by an abundance of nutrients, such as nitrates and phosphates, and algae, and a scarcity of oxygen. Excess fertilizers from agricultural activity, golf course maintenance, and even residential landscaping practices can flow downstream as runoff, reaching a river and ultimately, an estuary and coastal water. Sewage, industrial waste, and the burning of fossil fuels can also contribute to eutrophication.

While nitrates and phosphates promote the growth of algae and phytoplankton, too much of these nutrients will alter the system’s balance. The algae and phytoplankton reproduce rapidly and limit the penetration of sunlight. This is turn affects the plants growing beneath the water’s surface which can no longer photosynthesize. They die, as do the algal blooms. Bacteria decompose the dead plant material and in the process, use and deplete the dissolved oxygen in the water. Organisms suffocate, and a dead zone replaces what was once a highly productive estuary.

According to NOAA, nutrient pollution is the single largest pollution problem affecting the nation’s coastal waters, quite possibly exacerbating the effects of ocean acidification. Blooms of cyanobacteria often occur with eutrophication. Cynobacteria can taint drinking water supplies and deplete oxygen. Some release cyanotoxin, which is harmful to marine life and damaging to commercial fisheries.

**Key Words:**

***Dead zone***-an area in a body of water where low oxygen levels cause animal life to suffocate and die.

***Decomposition***-The breaking down of organic matter, like a dead plant or animal, into its chemical and mineral components.

***Estuary***-A coastal body of water created where a river or stream empties into the ocean or a bay and mixes with salt water.

***Eutrophicati*on**-A natural or human-caused process involving the addition of nutrients into a body of water and excessive growth of phytoplankton.

***Nonpoint source pollution***-Pollution that comes from a wide range of sources rather than single “point” such as a discharge pipe.

***Nutrient loading***-The amount of nutrients delivered to a body of water by way of a river or stream.

***Photosynthesis***-The process by which plants and algae convert light energy to chemical energy stored in carbohydrates.

***Phytoplankton***-Microscopic drifting algae that, like plants, photosynthesize and generate oxygen in the process.

***Watershed***-The region of land that drains water into a particular watercourse.

**To Do (part one):**

Display a map of the United States and have students locate various rivers on it. Lead a discussion about where most rivers drain**.** Where rivers meet ocean, what kind of mixing of water occurs? What does the coast look like where a river’s journey ends?

Distribute Handout One and ask students to read the paragraph, study the four images, and answer the questions.

**To Do (part two)**

Have students think about the consequences of contaminated river water reaching an estuary. Explain that sometimes things other than pollutants cause problems. Nutrients, such as fertilizer or soap, can run off the land, flow into a river or stream, and drain into an estuary. There it can promote heavy algae growth.

Distribute Handout Two and have students read the case study. Have them cut out the parameter cards and, depending on their grade level, work independently, in a small group, or as part of the entire class, to arrange them in correct sequential order. Discuss formation of a dead zone.

Set up the nutrient loading and eutrophication demonstration. This can be arranged as one teacher-led activity or several student-led small group activities (each based on use of four jars). Pour the collected water samples into the jars. For each set, label the first jar “baseline,” the second “ten,” the third “twenty,” and the fourth “thirty.” Add drops or granules of fertilizer to each jar based on these counts. Place the jars on a windowsill where there is sunlight. Challenge students to create a hypothesis and then record their observations each day for three days. If students have access to water quality test kits, have them take daily readings of dissolved oxygen, nitrate, and phosphate. Discuss results.

**To Do (part three**)

Distribute Handout Three. As a group, tour the school grounds to gain familiarity with campus water use and patterns of flow, including potential runoff. Look specifically at landscaped areas, playing fields, and parking lots. Have students record observations on their handout.

Meet for a pre-arranged interview with maintenance staff. Assign students to ask the questions appearing on Handout Three, and have each student record the responses they hear on their handout.

**Taking It Further:**

If warranted, have students create a list of recommendations to redirect or eliminate water runoff on the school campus.

**HANDOUT ONE: Estuaries**

An estuary forms where a river or stream empties into the ocean or a bay. Freshwater flows downstream and mixes with salt water brought in with the tides. As a river approaches the coast, it widens. Both the levels of salinity and the water itself change with the movement of the tides.

Estuaries occur in many of the world’s bays. They include the Tampa Bay on the East Coast and both the Puget Sound and San Francisco Bay on the West Coast.

Study the images below. Each shows a satellite image of an estuary in the United States. For each image, locate the river, estuary, and coast.

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San Francisco Bay Tampa Bay

**HANDOUT TWO**

**Case study**

The Neuse River is located in North Carolina. It begins its journey near Durham. It ends its journey at the Albermarle-Pamlico Sounds, an estuary on the Atlantic coast. The Neuse River Estuary is critical habitat for fish and shellfish, including blue crab and oyster.

The river flows past farmland, industrial lands, and suburban developments. By the time it reaches the coast, it is loaded with high amounts of nitrates, nitrogen, and phosphate. Wastewater discharges into the river and land use changes in general appear to be the culprits.

This nutrient loading results in nuisance blooms of algae. The algae as well as phytoplankton reproduce rapidly and limit the amount of sunlight in the water. Plants growing along the estuary floor no longer are able to photosynthesize. They die. The algal blooms eventually die as well. Bacteria decompose the dead plant material and in the process, use and deplete the oxygen in the water. Organisms in the estuary mudflats and open water suffocate. Fishkills occur and a dead zone replaces what was once a highly productive estuary.

**Parameter Cards**

Nutrients → river

Nutrients → estuary

Algae and phytoplankton ↑

Aquatic plants ↓

Algae and phytoplankton ↓

Bacteria ↑

Oxygen ↓

Estuary animals ↓

Dead zone is created

**HANDOUT THREE**

**Campus Runoff Audit**

**Sketch a plan view of the administration building, parking lot, driveway, and street**

**Observations:**

Does the school have an irrigation system?

How moist is the soil beneath the lawn or playing field?

Where do you think water on campus flows in a rainstorm?

Are cisterns in place to catch rainfall?

Are there rain gutters? If yes, are they directed to planted or paved areas?

Are swales in place to catch runoff?

Does the landscaping use plants that are adapted to the local climate?

Do you see any signs of leaks or drips?

**Maintenance Staff Interview:**

1. Does the school have an irrigation system? If so, how type of system is it? Does it get evaluated (for example, if sprinklers miss their mark, are they adjusted?)

2. If the school does not have an irrigation system, how do you determine when to water the landscaping?

3.Does the school use fertilizers on lawns and playing fields? How are application rates determined?

4. What practices are in place to reduce the amount of water running off campus?