

## Nutrient Enrichment of Phytoplankton in the Chesapeake Estuary A MWEE for 9th Grade Environmental Science Classes

### First Day of PLANS – Teacher-led classroom activity.

#### *Overview*

During this class the students will be evaluated to determine their current knowledge of nutrient enrichment and related Chesapeake Bay issues. Students will then be introduced to these topics by their teacher. Further, students will be introduced to PLANS and what their role will be in the program.

#### *Objectives*

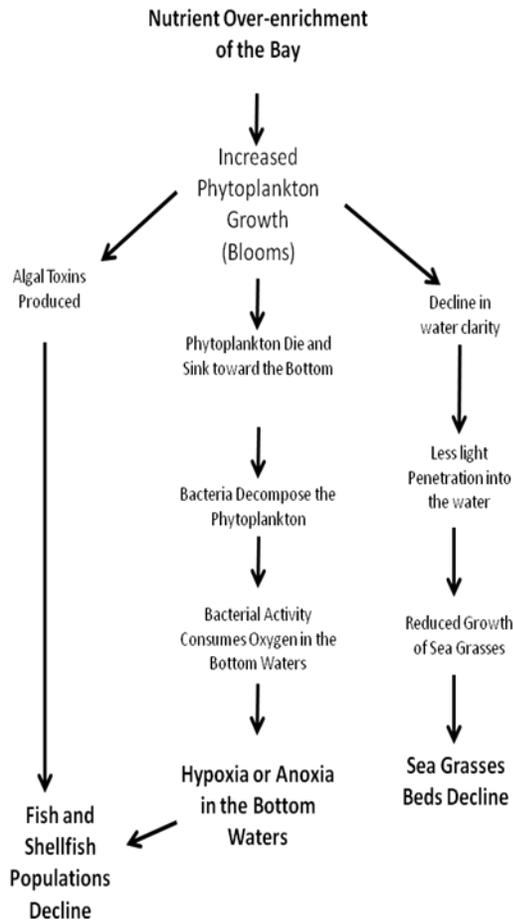
- Establish baseline student knowledge using a Pre-Program Assessment form – a link to this survey can be found on the PLANS website. [www.plansforthebay.org](http://www.plansforthebay.org)
- Gain knowledge of Chesapeake Bay nutrient enrichment (resources provided by PLANS)
- Introduce the students to the PLANS program

#### *Background*

An overload of nutrients, called eutrophication (Greek for “good-nutrition”), can be harmful to estuaries. This phenomenon is also referred to as “over-enrichment,” or “nutrient pollution.” The consumption and recycling of nutrients tend to keep nitrogen levels balanced. Bacteria release nitrogen back to the atmosphere at a greater rate than the natural flow of nitrogen into the estuary and the rate of nitrogen fixation. However, human activity can release large amounts of nutrients into the estuary that overwhelm the natural cycling of nitrogen.

Over-enrichment often causes “algal blooms” (or sometimes HAB “harmful algal blooms” in cases where the phytoplankton are toxic to marine organisms or humans) in estuaries. The influx of high nutrient levels causes excessive growth of algae. Too much phytoplankton in the water column can cause the water to become cloudy, reducing the amount of sunlight available for underwater plants to photosynthesize. Large algal mats floating on the surface can block the light that underwater plants such as seagrasses need. Disturbances to seagrass communities can be harmful to other organisms like fish and crabs that depend on the grasses for food, shelter, and nursery areas.

On sunny days, the bloom’s photosynthesis creates abnormally high levels of oxygen in the water. When algae die, they sink to the bottom where bacteria in the deeper waters and sediments decompose it. This process removes oxygen from the water. As bacteria decompose algae, more oxygen is consumed. If too much oxygen is removed from deep waters, the small organisms that fish and crabs eat die off. Oysters and other mollusks can also be harmed. Fish and other predators may die themselves or move to other areas in search of more oxygen. Therefore, algal blooms can disrupt food chains, damage estuarine habitats, and deplete oxygen to the extent that organisms die or move out. These processes are interrelated and depicted in Figure 1 below:



**Figure 1.** A concept map that presents the stepwise effects of nutrient enrichment on an estuary.

The conditions created by these blooms may encourage only species that can tolerate eutrophic conditions (blue-green algae). In addition, the appearance of the cloudy water and decaying algae mats, unpleasant odors, and loss of estuarine species can diminish the recreational value of estuaries.

Algal blooms may result from natural conditions, but they are often linked to excess nutrients that come from human activities. Excess nutrients may come from septic tanks, wastewater treatment plants, point source discharges from sewage and industry, exhaust from cars, emissions from industry, fertilizers from lawns, golf courses, farms, and animal waste (especially from livestock). Sources of nutrients that do not enter estuaries directly from point sources are transported to estuaries by stream flows, rain, leaching, groundwater, storm water, and as emissions carried through the air. Algae blooms usually occur seasonally. In the northern hemisphere, they typically occur between May and October. Heavy use of fertilizers in the spring combined with spring rains can introduce excess nutrients to the Bay.

Other conditions that favor algal blooms come into play in the months from summer to fall: bright sunlight, still water, and sharp temperature gradients that keep warmer surface water and colder bottom water from mixing.

### Materials Needed

- The student Pre-Program Assessment, available from the PLANS website under “Teacher Resources”
- The PowerPoint presentation on Chesapeake Bay nutrient enrichment, available from the PLANS website under “Teacher Resources”
- The PowerPoint presentation: Introduction to the PLANS program, available from the PLANS website under “Teacher Resources”

### Preparation

- Direct your student’s to the Pre-Program survey, available from the PLANS website under “Teacher Resources”

- Review the powerpoint presentations on Chesapeake Bay nutrient enrichment and the introduction to the PLANS program, available from the PLANS website under “Teacher Resources”. Modify these presentations as you would like to best convey this information to your students.
- Review optional Student Reading I: *An Introduction the Chesapeake Bay and the Patuxent River Estuary*. This reading could be assigned as homework to introduce the subject of nutrient enrichment in the Bay and Patuxent River.

### Procedure

#### A Pre-Assessment:

1. Before discussing any aspects of nutrient enrichment or the PLANS program with your students, begin the class by administering the Pre-program Assessment for the PLANS program.

#### Begin a Discussion:

2. Ask students why estuaries are one of the most productive ecosystems in the world. What conditions exist in the estuary that would make it particularly productive? *(Nutrients from land via runoff, surface tributaries, and groundwater, mixing and circulation of nutrients and oxygen by tides, abundance of food sources and protective habitats make the estuary a good place for rearing of many types of juvenile organisms and for diversity of species.)*
3. Ask students what types of nutrients estuaries need to support high productivity. *(Plants and animals need nitrogen and phosphorous, as well as many other trace nutrients. Nitrogen is a component of amino acids, enzymes, DNA, and proteins.)* If your students are familiar with the nitrogen cycle, you can suggest they consider how it functions in estuaries.
4. Have teams of students brainstorm ways in which the estuary receives the nutrients it needs. Again, if your students are familiar with the nitrogen cycle, you can suggest they consider how it functions in estuaries. Have them discuss and/or record responses to the following questions:
  - How do estuaries get necessary nutrients?
  - Are these nutrients obtained and simply used up or are they cycled through the estuary?
5. Discuss the teams' brainstormed ideas and answers. Ask if it is possible for an ecosystem to get too many nutrients.

Provide some Content:

6. Present the information found in the two Powerpoints: Chesapeake Bay Nutrient Enrichment and an Introduction to the PLANS program. *(Both of these Powerpoints can be modified to suit your class and time constraints.)*
7. Briefly conclude by announcing that the class study of “nutrient over enrichment” will begin by observing natural plankton samples during an up-coming class period.

### *Checking for Understanding*

To assess content learning, students could answer one or two of these questions as an in-class assignment or homework:

1. How could an over enrichment of nutrients in the estuary lead to the death of oysters in the deep waters of the Chesapeake Bay? Explain the series of events that link these two occurrences.
2. What land-use activities in Calvert County do you think contribute the greatest amounts of nutrients to the Bay? How do you think this list might be different if this list were being made 100 years ago? One hundred years from now? Provide the reasoning for your choices.