

actionbioscience.org lesson

To accompany the peer-reviewed article by Robert Howarth, Ph.D.:

“Bringing Dead Zones Back to Life” (Sept. 2000)

<http://www.actionbioscience.org/environment/howarth.html>

Dead Zones: Why Are the Waters Dying? (May 2002)

Lesson by John Ausema, biology teacher

Wilmington Christian School, Wilmington, DE

Educator's section: p. 1-3

Student handout 1: p. 4

Student handout 2: p. 5

Grades & Levels:

- **Handout 1:** high school (general)
- **Handout 2:** high school (advanced/AP) – undergraduate (year 1)

Time Recommendations: 1-3 weeks for each project (some activities can become semester projects)

NSES (USA) Content Standards, 9-12:

- NSES 1.1 Unifying Concepts & Processes: systems, order, and organization
- NSES 4.5 Life Science: matter, energy, and organization in living systems
- NSES 5.1. Earth & Space Science: energy in the earth system
- NSES 7.2. Science in Personal & Social Perspectives: population growth

Note: View the NSES content standards on this site to choose other curricular applications for additional activities at

<http://www.actionbioscience.org/educators/correlationcharts.html>

Learning Objectives: Students will ...

- understand how nitrogen pollution affects life in coastal zones
- examine the sources and causes of nitrogen pollution
- discuss possible solutions to pollution
- apply their knowledge to specific actions in their own lives

Key Words Include:

Dead Zone - a portion of a water body that has lost its oxygen, rendering it lifeless.

Nitrogen - an element necessary for plant growth; in the context of this article, it refers to nitrate, nitrite, and ammonia, which are compounds that contain nitrogen; they are used in fertilizers and produced by the breakdown of animal waste and wastewater.

Preparation

Article Discussion: The questions are divided into content, extension, and personal questions. Have the students read the article on their own at <http://www.actionbioscience.org/environment/howarth.html> and pose the questions in class for group discussion, or have students complete the content questions on their own and then discuss the more complex questions as a group.

- **What If? Scenarios:** Two scenarios follow the article questions. Students should work in groups to come up with a statement for each scenario. You might consider using the second scenario as a research project or homework assignment; alternatively, students could come up with a short statement in 10-15 minutes, based on information given in the article.

Student Handout 1 or 2: Some of the projects can be take-home assignments or multiple-day class activities.

For Educators: Article Discussion

About the article by Robert Howarth, Ph.D.:

“Bringing Dead Zones Back to Life”

<http://www.actionbioscience.org/environment/howarth.html>

Article Content Questions

1. What is a dead zone?
2. Describe the process by which a dead zone forms.
3. Other than oxygen depletion, what other problems are caused by excess nitrogen?
4. What is the primary reason for increases in nitrogen use over the last 30 years?
5. Explain the role of human activity in nitrogen pollution.
6. What role does nitrogen play in air pollution?
7. Why is it necessary for states to cooperate in addressing pollution problems such as this?
8. Explain several solutions suggested by the author.
9. What role is suggested for the federal government by the author?

Extension Questions

1. Define “pollution” in your own words.
2. Summarize the effects of nitrogen pollution using a diagram or concept map.
3. What percentage of coastal areas is affected by nutrient/nitrogen pollution?
4. What other kinds of pollution, other than nitrogen, threaten our health and safety?
5. What makes nitrogen pollution a national problem?

Personal Viewpoint Questions

1. What role, in your opinion, should the government take in solving the nutrient pollution problem?
2. What responsibility should farmers and other fertilizer users take to alleviate the problem?
3. What can home and automobile owners do to stop pollution in general?

“What If?” Questions

Both “what if?” scenarios are based on the diagram shown on page 3, which illustrates a bay near a coastal town and its nutrient pollution problems. Work in teams and be prepared to present your team’s solutions in class.

Scenario #1

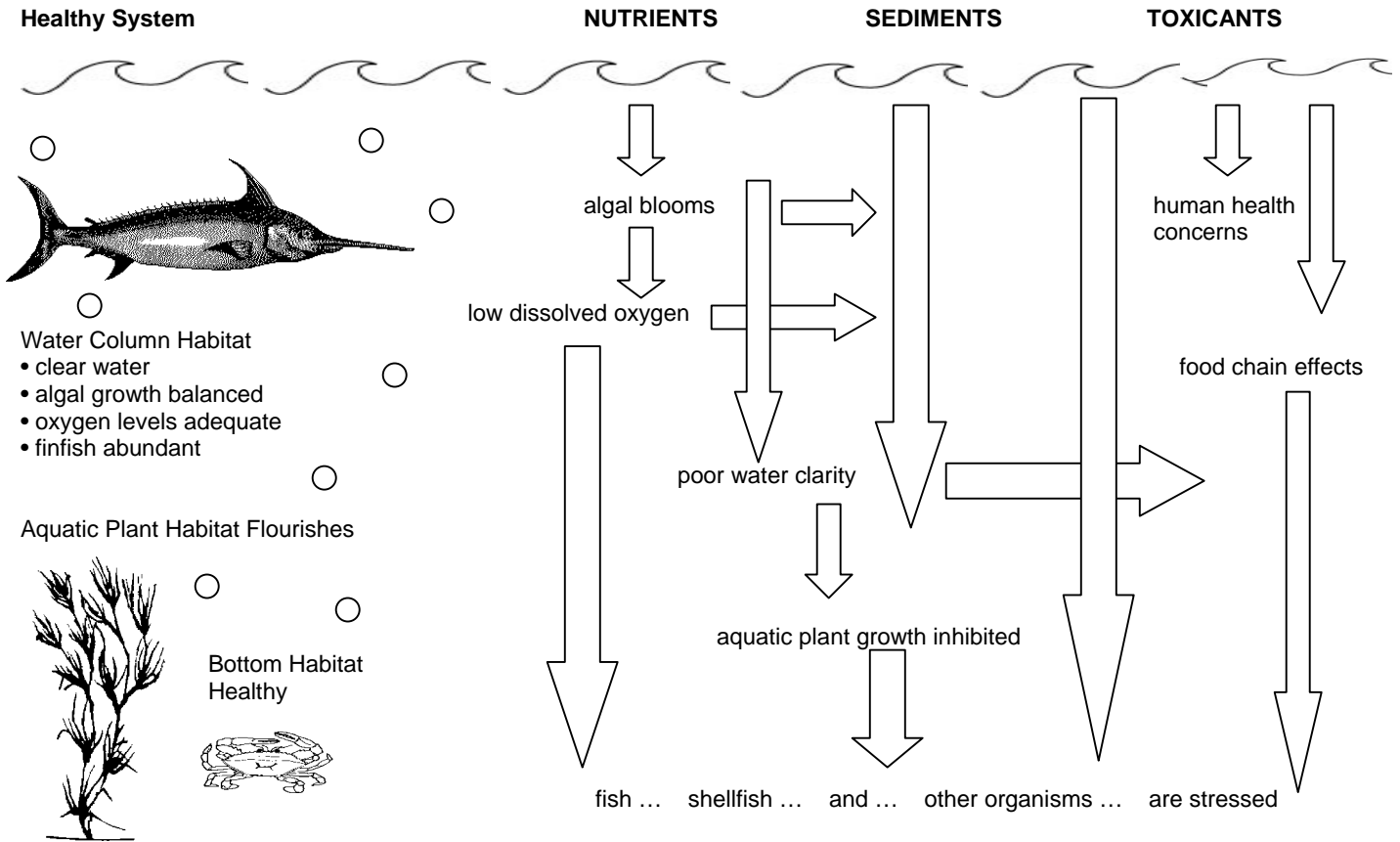
The local government has hired your consulting company to explain specific actions that could be taken to reduce the pollution problems. Your list of suggestions should include things that can be done by individual citizens of the coastal town.

Scenario #2

You own a local landscaping company. Suppose that the local government passes a law banning the use of lawn fertilizer in the coastal town.

- Come up with a statement, with reasons, to agree or disagree with the ban.
- Suggest alternate ways to do lawn care without fertilizer.

EFFECTS OF POLLUTANTS ON MARINE SYSTEMS
Based on illustration in a Chesapeake Bay Foundation newsletter.



Dead Zones: Why Are the Waters Dying?

Student Handout 1

Projects: Your instructor will tell you which projects are done individually, in teams, or as a class. Be prepared to make your presentation in class on the due date.

Hypoxia vs. Anoxia

Research hypoxia and anoxia. Create a chart that:

- defines the two terms
- summarizes the causes of each
- lists the effects of each on marine ecosystems

Keep notes with statistics and other information to support your chart entries. Present your chart in class and answer questions about your findings.

Global Dead Zones

Conduct research to find marine dead zones around the world. Draw or download a world map and highlight the marine dead zone areas. Then choose one of those dead zones for further study:

- list the causes of the pollution
- describe the effects of the pollution on the environment and population
- summarize what authorities are doing about the pollution in each area

Present your map and findings to the class. Be prepared to answer questions on your research.

Coral Reefs

Find out how coral reefs are affected by pollution. Summarize your findings in a report. Then research how artificial reefs may be one answer to solve coral reef problems. Make a list of types of experimental artificial reefs and summarize the features of each. You may want to draw and label the artificial reefs.

Dead Zones: Why Are the Waters Dying?

Student Handout 2

Projects: Your instructor will tell you which projects are done individually, in teams, or as a class. Be prepared to make your presentation in class on the due date.

Local Water Quality

Conduct water quality studies of a local stream, wetland, or pond. Then, contact local conservation officials to see if you can be a part of a citizen monitoring program for the water body you are interested in. Such projects usually ask participants to submit data on their adopted stream or pond once or twice per year. You can choose to be involved in the monitoring process, which may include writing reports on the effects of nitrogen pollution and making recommendations to local officials based on your findings.

Nitrogen and Algae

Study the effect of nitrogen on algae growth by doing controlled experiments in a large beaker or glass jar. Pickle jars work well for this. Set up experiments to

- test the effect of adding fertilizer to the jars, measuring the effect on the growth of algae or duckweed collected from local water sources
- use an electronic probe, if available, to measure the oxygen and nitrate levels over a period of several days. Report your results in standard scientific format, as a written report or a poster.

Total Maximum Daily Load

Research what has been done already to solve nutrient pollution problems in your area. Focus on the TMDL (total maximum daily load) approach that is required by the National Clean Water Act in your country. Create

- a timeline depicting the history of significant events in water quality control
- a flow chart indicating the regulation process mandated by the Clean Water Act

Information is available on government web sites, such as the EPA site (USA) as well as some of the others listed in the links at the end of the [actionbioscience.org](http://www.actionbioscience.org) article by Robert Howarth at <http://www.actionbioscience.org/environment/howarth.html>.

Contamination Simulation

Pollutants introduced into one area wind up in other places. Create a computer simulation of the path a pollutant might take over time from one point to other points in the area where you live. Include information about the pollutant's effects on:

- soil
- groundwater
- bodies of water such as rivers
- plants and animals
- residents (you included)