NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 1 HR 30 MINS

Water Quality Degradation in the Ocean

Students investigate causes of water quality degradation and analyze the relationship between harmful algal blooms, toxic algae, and dead zones. They explore water quality "success stories" and actions to improve water quality.

GRADES

9 - 12+

SUBJECTS

Biology, Ecology, Earth Science, Oceanography, Geography, Human Geography, Physical Geography

CONTENTS

8 Links, 4 PDFs, 3 Videos

OVERVIEW

Students investigate causes of water quality degradation and analyze the relationship between harmful algal blooms, toxic algae, and dead zones. They explore water quality "success stories" and actions to improve water quality.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/water-quality-degradation-in-the-ocean/

DIRECTIONS

1. Activate students' prior knowledge and assign a pre-reading assignment for homework.

Ask students to brainstorm the contexts in which they have heard the term *water quality*. Write students' responses on the board. Explain that water quality degradation is a major issue for both freshwater and marine systems. Ask:

- *Have you ever heard of a harmful algal bloom? When? Where?*
- *What is the relationship between algae, oxygen, and nutrients?*

Explain to students that phytoplankton, or algae, are like plants. They use nutrients, sunlight, and carbon dioxide to produce oxygen and food that support aquatic food webs. Explain that these processes of cycling nutrients, oxygen, carbon dioxide, and water are natural and essential for life. Sometimes the cycling or balance of these resources is disrupted, resulting in negative consequences for humans and wildlife. Tell students they will complete a reading assignment to learn more about water quality degradation. Provide students with hard copies or the online link to the National Geographic encyclopedic entry, "Dead Zone." Have students record the following vocabulary words: *harmful algal blooms (HABs), toxic phytoplankton, eutrophication, hypoxia, dead zone,* and *biomagnification*. Tell students to pay close attention to these terms as they read the entry. Point out that the term *biomagnification* is not used in the entry, but challenge students to research what it means and how it is related to water quality degradation.

2. Review the pre-reading homework assignment and vocabulary.

Ask student volunteers to summarize the main points of the National Geographic encyclopedic entry, "Dead Zone." Write the following definitions (without the matching terms) on the board, and number them so that students can match the definitions to the list of terms they wrote down and looked for throughout the entry. Have students first work individually and then pair up to check their answers. As a class, discuss which terms go with which definitions. Ask students if they are unclear about any of the terms and clarify as needed. Be sure to discuss *biomagnification* and which part of the entry it pertained to (the section about human and other marine animal illnesses).

- **Harmful Algal Blooms (HABs)**—accumulations of fast-growing, dense patches of harmful algae
- **Toxic phytoplankton**—a type of HAB that is poisonous to marine animals and to humans
- **Eutrophication**—a process in which bodies of water receive excess nutrients that stimulate excessive plant growth, such as algal blooms
- **Hypoxia**—a reduced level of oxygen in the water
- **Dead Zone**—an area of water with hypoxic conditions that kill most marine life
- **Biomagnification**—the increasing concentration of toxins as they move up the food chain

3. Have students work in small groups to complete the Water Quality Degradation worksheet.

Divide students into small groups and distribute the Water Quality Degradation worksheet. Explain to students that the water quality issues of toxic algae and dead zones have some similarities. Have groups use the National Geographic "Dead Zone" encyclopedic entry and "Harmful Algae" on the Woods Hole Oceanographic Institution site to answer the questions. Then use the provided answer key to review the correct answers with the whole class.

4. Ask small groups to research and generate hypotheses.

Distribute the Water Quality Degradation: Hypotheses worksheet and read aloud the two scenarios. Ask students to use what they have learned so far to generate hypotheses and support them with factual information.

5. Have students share and revise their hypotheses.

Ask each small group to share its hypothesis for toxic algae and the reasoning behind it. Click on the NOAA: Video Archive slide and show students the video "Sea Lion Sickness" (3 minutes). Discuss the most likely hypothesis for the toxic algae scenario. Have students confirm or revise their hypotheses. Ask each small group to share its hypothesis for dead zones and the reasoning behind it. Show students the NOAA video "The Dead Zone" (3 minutes, 50 seconds). Discuss the content of the video and have students confirm or revise their hypotheses.

6. Have students compare and contrast the two HAB-related water quality scenarios.

Distribute the Venn diagram worksheet, Compare and Contrast Toxic Algae and Dead Zones. Ask: *What are the similarities and differences between the two HAB-related water quality scenarios?* Have students work independently to complete the Venn diagram.

7. Have students use maps to trace the watersheds emptying into the Gulf of Mexico.

Ask students to look at the Water Planet Mega Map, included in the World Physical MapMaker Kit, paying special attention to the Gulf of Mexico. Remind them that they just learned about the annual "dead zone" in the Gulf and created a hypothesis for what could be causing it. Ask volunteers to come up to the map and trace with a marker the freshwater systems that connect to the Gulf of Mexico. Make sure students trace back to tributaries, or smaller waterways, which drain into the Mississippi River. Ask:

- *What waterways connect to the Gulf?*
- *What smaller waterways connect to those?*
- *What natural processes could be contributing to water quality degradation and the development of the Gulf dead zone?*

Elicit from students that the hydrologic cycle is a global/natural process that cycles and transfers water, nutrients, and other substances essential for life throughout terrestrial, atmospheric, and aquatic (freshwater and marine) systems. Then ask: *What anthropogenic activities or materials could be contributing to water quality degradation and the development of the Gulf dead zone*? Display the four National Atlas maps for reference. Elicit from students that areas of high agriculture, industry, development, and population density could all contribute. Remind them of the ways humans contribute to the eutrophication of freshwater systems, and eventually, marine systems like the Gulf. Examples include the use of fertilizers and detergents, deforestation and development that lead to soil erosion, inadequate wastewater treatment, sewage pollution, and contamination by livestock and poultry farms.

8. Have students read and discuss water quality success stories.

State that although water quality degradation is a serious threat to the health of humans and wildlife, efforts are being made to protect and improve the quality of our water. Project the National Water Program: Watershed Management Success Stories website. Ask students to read and discuss one success story as a class. Ask: *What actions are some people or groups taking to improve water quality?*

Modification

Pair this activity with a water sampling/water quality lab (marine or freshwater) or your biology curriculum's plankton and freshwater plant microscope lab.

Informal Assessment

Assess students' completed worksheets for completeness and accuracy.

Extending the Learning

Have students use the Watershed Management Success Stories website to research examples of how communities, governments, water quality managers, and task forces are working to reverse water quality degradation and improve water quality. Ask each student to summarize the organization or strategy and share examples of how water quality is improving and what individuals can do to address the problem.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

Earth Science

- Oceanography

Geography

- Human Geography
- Physical Geography

Learning Objectives

Students will:

- use scientific terminology to describe the ecological principles related to water quality degradation
- describe the general process that leads to algal bloom formation
- list ways in which harmful algal blooms can cause water quality degradation
- explain the potential negative effects that harmful algal blooms can have on marine organisms

- give examples of how human behaviors and activities have contributed to water quality degradation
- discuss examples of how humans have worked to improve water quality

Teaching Approach

- Learning-for-use

Teaching Methods

- Cooperative learning
- Discussions
- Information organization
- Multimedia instruction
- Research

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information Literacy
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Critical Thinking and Problem Solving
- Critical Thinking Skills
  - Analyzing
  - Understanding
- Geographic Skills
  - Acquiring Geographic Information

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **Standard 14:**
How human actions modify the physical environment
• **Standard 8:**
The characteristics and spatial distribution of ecosystems and biomes on Earth's surface

NATIONAL SCIENCE EDUCATION STANDARDS

• **(9-12) Standard C-4:**
Interdependence of organisms
• **(9-12) Standard D-1:**
Energy in the earth system
• **(9-12) Standard F-4:**
Environmental quality
• **(9-12) Standard F-5:**
Natural and human-induced hazards

OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

• **Principle 6e:**
Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (such as point source, non-point source, and noise pollution) and physical modifications (such as changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
• **Principle 6f:**
Coastal regions are susceptible to natural hazards (such as tsunamis, hurricanes, cyclones, sea level change, and storm surges).
• **Principle 6g:**
Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Markers
- Pencils

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per small group, Projector, Speakers
- Plug-Ins: Flash

PHYSICAL SPACE

- Classroom
- Computer lab

GROUPING

- Large-group instruction
- Small-group instruction

OTHER NOTES

Complete Step 1 the day before doing Steps 2-8 of the activity, and assign the National Geographic Education encyclopedic entry "Dead Zone" as a pre-reading homework assignment.

Before class begins, download and queue up the videos and animations. Using the MapMaker Kit Assembly video as a guide, print, laminate, and assemble the Water Planet Mega Map before starting this activity.

BACKGROUND & VOCABULARY

Background Information

Marine organisms have adapted to living in a variety of aquatic ecosystems that are impacted by natural and human-related changes. One of the most serious threats to marine organisms is water quality degradation due to nutrient pollution, harmful algal bloom formation, and hypoxia, or low oxygen levels. Monitoring and improving water quality can be challenging, because the harmful organisms and chemicals that threaten water quality are often microscopic, difficult to remove, and can accumulate within the food web and over time.

Prior Knowledge

["ecological principles related to food webs, adaptations, niche selection, and symbioses", "interactions between biotic and abiotic ecosystem components"]

Recommended Prior Activities

- Our Interconnected Ocean

Vocabulary

Term	Part of Speech	Definition
biomagnification	*noun*	process in which the concentration of a substance increases as it passes up the food chain.
dead zone	*noun*	area of low oxygen in a body of water.
eutrophication	*noun*	build-up of sediment and organic matter in bodies of water, which may cause a change in the productivity of the ecosystem.
harmful algal bloom (HAB)	*noun*	rapid growth of algae, bacteria, or other plankton that can threaten an aquatic environment by reducing the amount of oxygen in the water, blocking sunlight, or releasing toxic chemicals.
hypoxia	*noun*	condition of not having enough oxygen in a substance, such as water or blood.
toxic phytoplankton	*noun*	aquatic organism that produces chemicals that, in large amounts, can be deadly to plants and animals.

For Further Exploration

Websites

- NOAA: Tides & Currents—Harmful Algal Bloom Operational Forecast System (HAB-OFS)
- National Geographic News: "'Dead Zones' Multiplying Fast, Coastal Water Study Says"
- National Geographic News: "Sea Lion Seizures May Result From Toxic Algae"
- Bigelow Laboratories: Phytopia—Special Topics
- National Geographic Education: National Teacher Leadership Academy (NTLA)

FUNDER

ORACLE

NATIONAL GEOGRAPHIC

© 1996-2023 National Geographic Society. All rights reserved.