Water: Is It Clean Enough to Drink?

Essential Question: How do we define and identify clean water?

Introduction/Background

Pure water (H_20) almost never exists in nature. Even raindrops that condense in clouds are filled with dust and bacteria. By the time water enters a lake or stream, it is filled with other chemicals, gasses, and organisms of all kinds.

What makes water clean enough for animals (like fish) to live in? What makes it clean enough for humans to drink? The Environmental Protection Agency (EPA) talks about "stressors" caused by human actions, which change the structure, function, and taxonomic communities in the body of water. Instead of "health," they talk about biological integrity or the natural biological condition of a water body, undisturbed by human activity. (See EPA resources below.)

Students can identify abiotic factors (like silt or chemicals) that affect the living things in a body of water. They can also get clues to the quality of water by the diversity and the types of species that are living in it. The most widely accepted definition of "health" in a body of water is its biodiversity. That's normally associated with high levels of dissolved oxygen and the presence of a variety of organisms that need this high oxygen content. Pollutants like E. coli bacteria compete for oxygen, and create an aquatic environment in which only a few kinds of living things can survive. Using relatively simple techniques, students can get a sense of the biological health of a body of water.

National Science Education Standards

Content Standard C: As a result of their activities in grades 5-8, all students should develop an understanding of:

- Populations and Ecosystems
- Diversity and adaptations of organisms

Student Learning Objectives

As a result of these activities, students should be able to:

- Identify abiotic factors that characterize a body of water
- Test for abiotic factors
- Identify biotic factors like macroinvertebrates that live in clean and polluted water
- Describe what makes a "healthy" stream

Materials List

For sampling macroinvertebrates

- white shallow tray
- hand lens
- Key
- large baster or other instrument to sample water near the bottom of a body of water

For sampling abiotic factors

- Thermometer
- pH paper or meter
- Secchi disk*
- nitrate and phosphate test strips

Procedures

Part I: Look Alive!
You can get a quick sense of the biological health of a body of fresh water by identifying the types of macroinvertebrates in it. Students should begin by collecting water from near the bottom of a body of water. (A large turkey baster works well.) Put the water in a white, shallow pan (either enamel or Styrofoam) and then use a hand lens to classify macroinvertebrates.

The adjacent chart from EPA can be used to characterize the water. Sensitive organisms are signs of high oxygen content, low turbidity, and a "healthy" stream.

Pollution tolerant benthos can live in water that has very low dissolved oxygen. That can occur when bacteria, decaying matter or waste enters a stream, or when turbidity (sand or silt) prevents plants from photosynthesis.

Part II: Testing the Limits.

Sensitive Benthos

- Stoneflies
- Water Penny Beetles
- Mayflies
- Dobsonflies
- Alderflies
- Snipeflies
- Mussels
- Riffle Beetles

Moderately Tolerant Benthos

- Damselflies
- Dragonflies
- Crayfish
- Amphipods
- Blackflies
- Caddisflies
- Isopods
- Craneflies

Pollution Tolerant Benthos

- Midgeflies
- Worms
- Leeches
- Pouch Snails

Ask students to develop a database to explain their observations of macroinvertebrates by testing for pH, nitrates, and phosphates using test strips.

Test for water turbidity using a Secchi disk (directions in link below.)
Finally ask students to measure water temperature.

Safety Notes
All activities in and around water require special preparation and precautions. In addition, water testing presents risks. All chemicals brought to a field site must be accompanied by the same precautions (eye protection, gloves, MSDS sheets) that would be used in a laboratory, so in general it is far more practical to use dry water test strips for measuring water chemistry.

While students may discuss whether water is "drinkable," students should never drink from a natural stream or lake.

Data

Invertebrates	Sensitive	Moderately Tolerant	Tolerant
Temperature		Nitrate Level	
pH level		Phosphate Level	

Conclusions
Students should be able to relate their observations of abiotic factors to their observations of living things, and then extend those observations to hypotheses about larger living things like fish and mammals.

Evaluation
Ask students to formulate a hypothesis about the stream or body of water they are studying such as:
This body of water is healthy (unstressed) because…
Or

This body of water is unhealthy (stressed) because…
Then ask students to formulate at least four lines of evidence to support their hypothesis.

Adaptation/Elaboration
Students can use keys to match the larval state of a macroinvertebrate with the adult form.

While students can use macroinvertebrate studies, temperature, and turbidity as indirect measures of biological oxygen demand, more advanced students will benefit from direct measurements with kits such as those sold by LaMotte Company

Where students have identified a stressed water system, they can use references such as nationalatlas.gov to identify (EPA registered) potential point sources of pollution. They can also use sources such as GoogleEarth™ to follow the creek upstream and identify natural point sources such as farms and feedlots.

Sources
Biological Indicators of Watershed Health.
http://www.epa.gov/bioiweb1/html/about.html

Best Practices for Identifying Reference Conditions for Mid-Atlantic Streams.
http://www.epa.gov/bioindicators/pdf/EPA-260-F-06-002BestPracticesforIdentifyingReferenceConditionsinMid-AtlanticStreams.pdf

Testing the Waters.
http://earthobservatory.nasa.gov/Features/WaterQuality/water_quality2.php

A Website for Sharing Water Monitoring Information.
http://www.mtwatercourse.org/

A Website and Newsletter with Information.
http://www.montanawatershed.org/

A Website Featuring Water Monitoring with Students.
http://www.cfwep.org/