# How healthy is your stream?

A hands-on assessment of the chemical and physical properties of stream water using the visual arts.

For grades 7-12

Created by the Athens-Clarke County Stormwater Management Program

## Lesson Summary

Students perform hands-on chemical and physical water quality testing and utilize their creativity to create visual representations of water quality. This lesson encourages active data collection and synthesis and incorporates art into the scientific process.

## Objectives

- Students will learn that water quality is a complex, multi-faceted concept.
- Students will learn how to collect water quality data and develop new ways to represent the data.
- Students will synthesize multiple metrics into one comprehensive assessment of stream health.
- Students will be able to translate the data into predictions about the stream's habitability for a specific fish species.
- Students will be able to utilize visual arts to communicate scientific concepts.

## GSE Science Major Concepts

**Biology**

SB5. Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment.

**Chemistry**

SC6. Obtain, evaluate, and communicate information about the properties that describe solutions and the nature of acids and bases.

**Environmental Science**

SEV1. Obtain, evaluate, and communicate information to investigate the flow of energy and cycling of matter within an ecosystem.

SEV2. Obtain, evaluate, and communicate information to construct explanations of stability and change in Earth's ecosystems.

SEV3. Obtain, evaluate, and communicate information to evaluate types, availability, allocation, and sustainability of energy resources.

SEV4. Obtain, evaluate, and communicate information to analyze human impact on natural resources.

SEV5. Obtain, evaluate, and communicate information about the effects of human population growth on global ecosystems.

## Materials

- stream water
- gloves
- goggles
- pH test kit
- turbidity test kit
- dissolved oxygen test kit
- clipboards
- data sheets
- pencils
- graph paper
- colored pencils

## Safety Note

Participants should wear gloves and goggles while conducting water quality tests. After the activity, all waste must be properly disposed.

# Background Information

This activity focuses on four measures of water quality: temperature, turbidity, pH and dissolved oxygen.

## Temperature

Water temperature affects the amount of dissolved oxygen in the water, the rate of photosynthesis in aquatic plants and the sensitivity of organisms to toxic wastes, parasites and disease. These four things can affect water temperature:

- Thermal pollution, the discharge of heated water from industrial operations.
- Amount of tree canopy and shade surrounding the water body.
- Stormwater runoff, which contains water warmed by streets and sidewalks.
- High turbidity.

Georgia Water Testing Parameters:  Water temperature is not to exceed 90°F.

## Turbidity

Turbidity is the relative clarity of water. Turbidity is not the same as color: darkly colored water is not necessarily turbid.

Turbidity diffuses sunlight and slows photosynthesis, causing plants to die and reducing the amount of dissolved oxygen. Because decaying organic matter produces carbonic acid, this increases the water's acidity, too. Lower dissolved oxygen and higher acidity harm aquatic animals.

The suspended particles of decaying organic matter absorb the sun's heat, raising water temperature. Warmer water holds less oxygen, further decreasing the dissolved oxygen. Additionally, turbid water can clog fish gills, stunt growth and decrease disease resistance. Since organic materials, which can cause turbidity, can serve as breeding grounds for pathogens, decreased disease resistance in aquatic animals is also a big problem.

Furthermore, when drinking water reservoirs are turbid, the water treatment plant usually has to filter the water before disinfecting it, which costs time and money. Highly turbid water can also clog machines and impede food and beverage production.

Four main things cause turbid water:

- Suspended matter, like clay, silt and organic and inorganic matter.
- Disturbance of the stream bottom, caused by boats, bottom feeders and stormwater runoff.
- Microscopic organisms, such as algae.
- Urban runoff, which can introduce sediment from construction or dirt from roadways.

Georgia Water Testing Parameters: Turbidity within 0–40 Jackson Turbidity Units.

## pH

The pH indicates how acidic or basic the water is. The pH scale ranges from 0 to 14. A pH below 7 is acidic, while a pH above 7 is basic. A pH of 7 is neutral.

A pH of 6.5 to 8.2 is optimal for most plants and animals, and most natural waters have a pH of 5 to 8.5. Four things may affect pH:

- Acidic, freshly fallen rain water, which may decrease the pH.
- Decomposition of organic materials, which, by releasing carbon dioxide that converts to carbonic acid, may decrease the pH.
- Alkaline soils and minerals like limestone, which can raise pH up to 8.5.
- Algae and vegetation remove carbon dioxide from the water during photosynthesis, which can increase pH.

Georgia Water Testing Parameters: pH should be between 6 and 8.5.

## Dissolved oxygen

Aquatic animals and plants need dissolved oxygen to live. Oxygen dissolves into water from the atmosphere both as a by-product of photosynthesis and through water movement. Cold water can hold more dissolved oxygen than warm water, which can mean large fluctuations in dissolved oxygen throughout the day, affecting the ability of plants and animals to thrive.

Between 5 and 6 mg/L is a healthy amount of dissolved oxygen for aquatic plants and animals. Dissolved oxygen levels below 3 mg/L are stressful to most aquatic organisms, and levels below 1–2 mg/L will not support fish. Dissolved oxygen decreases when:

- Turbidity increases water temperature.
- Thermal water pollution increases water temperature.
- Bacteria use up the dissolved oxygen during the decay of organic matter.
- Water is stagnant.

Georgia Water Testing Parameters: Dissolved oxygen should average 6 mg/L daily, never less than 5 mg/L.

## Procedure

Discuss the importance of chemical and physical water quality sampling. Water sampling and monitoring is important when determining the health of the body of water and of the entire watershed. Three different characteristics of a body of water are tested to determine its condition. Ask the students to name them and give examples of each.

- Chemical: pH, dissolved oxygen.
- Physical: temperature, turbidity, bank erosion.
- Biological: Benthic macroinvertebrates, fish, plants.

Explain that this activity focuses on the chemical and physical characteristics. Use the background information to discuss the water sampling parameters and their causes and effects on the local environment. Inform students that a stream's chemical, physical and biological characteristics change on a daily, weekly, seasonal and yearly basis.

Divide the participants into five groups of three or four students each. In a formal, large group setting, cap the number of students in each group at five. Each group will study the habitat requirements for one fish species (Threadfin Shad, Black Crappie, Largemouth Bass, Bluegill, and Channel Catfish) seen on the last page of this document. At the end of the activity, each group should be able to determine if their fish species can survive in the body of water from which the sample was collected.

Review safety precautions. Pass out gloves, goggles, pencils, and clipboard with activity sheet to each group. Depending on space and number of instructors, the chemical and physical water quality sampling can be done as one group or broken into separate groups.

Students will divide roles within their groups for the following steps:

Begin with turbidity testing. One student will fill up the turbidity cylinder with the collected water. Compare the clarity of the water in the beaker with the turbidity scale in the kit. Find the best match, and record the data on the activity sheet.

Next, measure the water temperature by placing the thermometer in the water. Make sure the thermometer is in the water, but not touching the soil at the bottom of the cylinder. Leave the thermometer in the water for two minutes, then record the temperature on the activity sheet.

Next, measure the pH. Give each group a test tube. Fill the test tube with water. Add ten drops of the indicator solution. Gently shake the test tube until the water is unison in color. Compare the color of the water to the pH scale. Record the pH value that most closely matches the water color.

Finally, measure the dissolved oxygen. Give each group a test tube. Fill the test tube completely with water. Place two dissolved oxygen tablets in the test tube. Gently shake the test tube for 5 minutes. Compare the color of the water to the dissolved oxygen scale. Record the dissolved oxygen value that most closely matches the water color.

Note: other testing methods are possible for each of these tests. If you have a different kit or protocol, please follow those instructions.

## Assessment

Students will compare their findings to the habitat requirements of their fish species. Each group will make an informed prediction about the survival of their fish species and present their findings. Ask questions about chemical and physical water quality metrics to gauge knowledge retention.

Sample questions include:

- How does turbidity affect dissolved oxygen? Which other chemical or physical characteristic is involved in this relationship?
- An algae bloom occurs when fertilizer enters a body of water and promotes algal growth. How would an algae bloom affect dissolved oxygen? The pH?
- How are temperature and dissolved oxygen related?
- What would you do to increase the health of this stream?

## From STEM to STEAM: Connecting to art

Novel and creative data visualization is critical for presenting complex data. Much ecological data, such as water quality, encompasses many metrics, some of which are interrelated. Ask students to think outside the standard graph to create an informative summary of their data. Provide colored pencils and graph paper. If students seem stuck, provide examples of interesting data visualizations.

# Fish Species

Use this fact sheet to determine whether your fish species could survive in the stream. Compare the data you collected with the data in this sheet. Think about each aspect of stream health individually and as a whole.

Fish species data collected from U.S. Geological Survey and New Jersey Division of Fish and Wildlife fact sheets.

## Threadfin Shad

Temperature: 70
Turbidity: < 40 JTU
pH: 6–8.5
Dissolved oxygen: > 5 mg/L

## Black Crappie

Temperature: 64
Turbidity: < 40 JTU
pH: 6.5–8.5
Dissolved oxygen: > 5 mg/L

## Largemouth Bass

Temperature: 61
Turbidity: < 40 JTU
pH: 6.5–8.5
Dissolved oxygen: > 8 mg/L

## Bluegill

Temperature: 63
Turbidity: < 40 JTU
pH: 6.5–8.5
Dissolved oxygen: > 5 mg/L

## Channel Catfish

Temperature: 70
Turbidity: < 40 JTU
pH: > 5.7
Dissolved oxygen: > 7 mg/L