

# An Estuary Field Study

**Lesson Focus:** Water sample analysis and estuarine systems

## **Enduring Understandings:**

- Estuaries are unique environments where freshwater mixes with saltwater.
- Human activities can impact the health of estuarine environments.
- Chemical testing is an important part of monitoring the health of estuaries.

## **Learning Objectives:**

- Students will learn what an estuary is and will identify local estuarine environments.
- Students will learn and practice proper procedures for handling chemicals in the lab and in the field.
- Students will collect water samples, conduct various chemical tests on the samples, and record appropriate data.
- Students will use chemistry to evaluate the impacts of human activities on the local estuaries.

## **Georgia Performance Standards Addressed:**

SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.

- a. Follow correct procedures for use of scientific apparatus

SCSh3. Students will identify and investigate problems scientifically.

- c. Collect, organize and record appropriate data
- d. Graphically compare and analyze data points and/or summary statistics
- e. Develop reasonable conclusions on data collected

SC5. Students will understand that the rate at which a chemical reaction occurs can be affected by changing concentration, temperature, or pressure and the addition of a catalyst.

- a. Demonstrate the effects of changing concentration, temperature, and pressure on chemical reactions.

SC7. Students will characterize the properties that describe solutions and the nature of acids and bases.

- a. Explain the process of dissolving in terms of solute/ solvent interactions.
- b. Compare, contrast, and evaluate the nature of acids and bases:
  - Strong vs. weak acids/bases in terms of percent dissociation
  - Hydronium ion concentration
  - pH
  - Acid-Base neutralization

**Grade level:** 10<sup>th</sup>

**Materials:**

- LaMotte water monitoring kits (one for each group of students)
- Refractometer (one can be shared between all the groups)
- Sampling buckets (one for each group of students)
- Latex or vinyl gloves (several pairs for each student)
- Safety glasses
- Student field notebooks (one for each student)
- Copies of a local map (one for each student)
- Access to an estuarine environment
- Container for waste liquids from water quality tests

**Time Needed:** Half or full day for field trip, plus one full class period before and half period after.

**Background Information:**

An estuary is a body of water partially surrounded by land, where fresh water from a river mixes with Ocean water. Estuaries are surrounded by mud, sand, barrier islands, or reefs which protect them from wind and waves. These protected areas provide feeding, breeding, and nesting grounds for a wide variety of species, including fish, shellfish, birds, amphibians, reptiles, and insects.

Estuaries are important to humans for multiple reasons. Estuaries act as buffer zones, helping to protect shorelines and inland communities from flooding and storms. They also act as nurseries for many saltwater and freshwater species. Many species of fish and shellfish, including most of those that we eat and fish, both commercially and recreationally, live some part of their lives in estuaries. Estuaries also filter out pollutants and sediment from the water, improving water quality and protecting marine habitats, as well as provide many recreational opportunities such as fishing, swimming, and boating.

More than half of U.S. residents live within 100 miles of the coast, and coastal communities are growing rapidly. Unfortunately, large populations in these areas and along the rivers upstream are threatening the health of our estuaries and causing problems such as algal blooms from excess nutrients, buildup of toxic chemicals in fish and shellfish, loss of habitat by coastal development, and disruption of normal water flows and sedimentation.

Chemical monitoring is an important part of protecting and managing these ecosystems. By testing, recording and tracking parameters such as nutrient levels, dissolved oxygen, pH, and salinity, we can get a good idea of the health of an estuarine ecosystem and how it is changing over time.

In this field study students will sample and conduct chemical tests to assess human impact on this system and relate this to the use of chemistry to monitor these impacts. It is important to remember that estuaries and watersheds are all connected and human activity anywhere in the system could impact the entire system.

### Water Quality Parameters

**Temperature** The temperature of the water in a specific habitat is one of the most important determining factors for which animals can live there. Temperature can impact an animal's ability to respire, feed and reproduce. Temperature will fluctuate naturally with seasonal change, but these changes usually happen slowly, giving organisms time to acclimate. Sudden changes in temperature can send animals into shock, and very warm water often cannot hold enough oxygen for fish and other sensitive species. In the wild, sudden temperature changes or overheating of the water is usually caused by loss of tree shade, and run-off that is heated by hot asphalt and roof tops as it makes its way into the nearest natural waterway.

**pH** All liquids are either considered acidic, neutral or basic. The scale that is used to determine these factors is referred to as pH. On the pH scale, the measurements range

from 0 to 14. Distilled water is rated at 7.0, or neutral. Substances that measure below 7.0 are considered acidic, while those above 7.0 are considered basic. Most aquatic animals prefer to live in a habitat that ranges from 6.5 to 8.2. As you can see from a list of the following liquids, the further away from 7.0 the pH reading falls, the less habitable it is:

<b>Liquid</b>	Battery Acid	Lemon Juice	Rainwater	Distilled Water	Salt Water	Ammonia	Bleach
<b>pH Level</b>	0.5	2.0	5.9	7.0	8.0	11.2	12.9

In the wild, pH levels can vary for a number of reasons. As you can see in the chart, rain adds a slight level of acidity to water, especially if that rain contains high levels of sulfur (acid rain) caused by air pollution, while salt makes water more basic. Decomposing matter, such as leaves, will also make water more acidic. Pollution from factories and chemical run-off from the fertilizers and pesticides we use on our lawns can also affect pH levels.

**Dissolved Oxygen (DO)** Aquatic organisms have special adaptations that allow them to obtain the oxygen they need from the water where they live. However, the amount of oxygen in the water can vary, depending on how fast the water is moving, salinity, levels of turbulence, and temperature. In general, colder, faster-moving water holds more oxygen. Thus, in Georgia, animals that need more oxygen-rich water, such as trout, are found in the cold, white-water rivers and streams of the North Georgia Mountains, and not in the slow moving, warm wetlands of the Okefenokee Swamp.

While DO varies naturally between habitats, human actions can also have an effect. The loss of trees in *riparian zones*, or the vegetated edges of waterways, can leave little to shade the water's surface from the sun. In addition, the introduction of certain nutrients, such as phosphorus and nitrogen, can cause *algae blooms*. Algae are generally small, plant-like organisms which produce food through photosynthesis. When algae grow and bloom all at once, it often uses up the oxygen in the water for this process. Phosphorous and nitrogen are commonly found in soaps and fertilizers, and can be introduced into the water through run-off from factories, farms, animal waste, lawns, people improperly washing their cars, and other human activities.

**Salinity** Scientists refer to the level of salt found in water as its *salinity*. Obviously, we expect to find saltwater in the Ocean, and not in freshwater habitats such as rivers,

streams and lakes. However, in *estuaries*, freshwater rivers mingle with Ocean water pushed inland by waves and tides in flat, wetland areas. In estuaries, where rivers meet the Ocean, salt water is diluted by freshwater, creating a fluctuating level of salinity that supports a wide variety of wildlife.

Sometimes, freshwater habitats are damaged by saltwater. This can happen during floods and hurricanes, when ocean water overflows estuaries and pushes further back into freshwater rivers. Places where estuaries and other marine wetland areas have been drained or damaged due to development and construction are more vulnerable to salt water intrusion, because wetlands often act like sponges, absorbing and filtering the water that passes through.

**Nutrients** The buildup of nitrogen, phosphorus, and other nutrients is called eutrophication. Some non-point source pollution such as fertilizer, animal waste runoff, and detergent from households speeds up this process, increases the level of nitrates and phosphorus, and creates water quality problems such as algae blooms. The animals of the ecosystem are affected by this. The oxygen in the water is depleted due to the increased amount of plant matter, therefore the fish have a more difficult time breathing.

- **Nitrates** Unpolluted waters generally have a nitrate-nitrogen level below 1 ppm. Nitrate-nitrogen levels above 10 ppm are not safe for drinking. A high level of nitrate-nitrogen may mean there are fertilizers, animal waste, or sewage in the water.
- **Phosphorus** Phosphorus levels higher than 0.03 ppm stimulate plant growth. Total phosphorus levels above 0.1 ppm can lead to oxygen depletion due to plant growth. Levels above 0.1 ppm might mean there are industrial soaps, sewage, fertilizers, or animal waste in the water.

## **Learning Procedure:**

Before the trip:

1. Divide the students into groups of 4 or 5. In a pre-trip lab session, have each group read and practice the procedures to perform the tests for dissolved oxygen, nitrate, pH and phosphate using the instruction manual from the LaMotte low cost Water Monitoring kits. Demonstrate for the students and have them practice the proper methods for measuring temperature and salinity.

2. As homework after the lab session, have the students research these water quality parameters, their effects on aquatic habitats, and how humans influence them and summarize these findings in their field notebooks.

#### Day of trip:

1. Drive to the first test site and pass out supplies (sampling buckets, testing kits, gloves, garbage bags, etc.)
2. Have each group collect a water sample and test for temperature, salinity, dissolved oxygen, nitrate, pH and phosphate following the procedure they learned in the lab. They will need to record their results in their field notebooks.
3. Also have the students mark the testing location on their maps.
4. Repeat this same procedure for multiple test sites.

#### After the trip:

1. Have students work together with their groups to make sure everyone has all the data recorded.
2. As a class, discuss the groups' findings. What challenges did they face? Did they have any unexpected results? What do they think might have caused these? What factors could account for any variation in results between different groups?
3. Using the information they gathered before the trip on water quality parameters and human impacts, have the students suggest ways that the estuary may be affected by the local communities. Do their sampling results support these theories?

#### **Evaluation:**

Students will complete a group display and an individual written report. They will organize the data collected into tables and graphs and complete a report relating the findings during the field study with regard to the health of the estuarine system, human impacts upon the system and chemistry's role in helping to monitor these impacts (see rubric for requirements).

## Extensions:

1. The field study can be repeated at a different time of year to assess the effects of different temperatures, tidal stages and rainfall amounts on the parameters tested.
2. Students could test a location along the coastal river above the tidal influence to see how this affects the tested parameters.
3. Have students research ocean acidification and design a demonstration that visually explains the impacts on Ocean habitats and organisms as the pH level drops.

## Resources:

The New Georgia Encyclopedia: Savannah River

[www.georgiaencyclopedia.org/nge/Article.jsp](http://www.georgiaencyclopedia.org/nge/Article.jsp)

Garrison, Tom: 2007; Oceanography, an Invitation to Marine Science; Thompson Brooks/ Cole

LaMotte Low Cost water monitoring kit instruction manual

USEPA: <http://www.epa.gov/nep/kids/about/what.htm>

NOAA's National Ocean Service:

[http://oceanservice.noaa.gov/education/kits/estuaries/estuaries02\\_economy.html](http://oceanservice.noaa.gov/education/kits/estuaries/estuaries02_economy.html)

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