

Water Chemistry Monitoring

Chicago River Fieldtrip Activity

Summary

Students use basic to advanced water quality monitoring kits and probes to assess the water quality of the Chicago River.

Water chemistry kits available for loan from Friends of the Chicago River include: GREEN© kits (biological oxygen demand, dissolved oxygen, fecal coliform, nitrates, pH, phosphate, turbidity), Hach© kits (biological oxygen demand, dissolved oxygen, nitrates, pH, phosphate), Coliscan Easy Gel© (fecal coliform/e coli) and a turbidity tube.

Background

With chemical tests you are testing for the presence and concentration of specific chemicals. Results will only tell you about the specific chemicals you tested, not about the possible presence of other pollutants. Chemical tests also only tell you what is present in the water at the moment you test. Factors, such as antecedent weather conditions (such as rainfall), time of day and year, will affect values.

Oxygen

Importance: breathed by aquatic animals

Sources: by-product of photosynthesis, mixed in from air when water is turbulent (in riffles)

Values:

0-3ppm: Few organisms can survive.

3-4ppm: Only a few fish and invertebrates can survive.

4-7ppm: Most non-trout, warm-water fish species can survive.

5ppm: EPA's suggested lower limit to maintain healthy aquatic biota.

>7ppm: Necessary for trout, salmon and many invertebrates.

pH

Importance: indicates the number of free hydrogen ions in the water [$\text{pH} = -\log_{10}(\text{H}^+)$], too high (alkaline) or too low (acidic) a value will preclude many forms of life from living

Grade Level: 5th -12th

Duration: Variable (depending on type of monitoring kit used, experience of students and number of tests performed)

Objectives:

1. Students will follow written instructions to determine the value of a variety of water quality indicators of the Chicago River.
2. Students will be able to explain what the water quality values mean for the health of the river.
3. Students will be able to infer what might be causing any water quality impairments.

Materials:

- ◆ Water quality testing kits, enough for students to share
- ◆ Water quality data form, one per group

Standards:

11.A.3a, 11.A.4a, 11.A.5a, 11.A.3c, 11.A.4c, 11.A.3d, 11.A.4d, 11.A.5d, 11.A.3e, 11.A.4e, 11.A.5e, 11.A.3f, 11.A.4f, 11.A.3g, 12.B.3a, 12.B.4a

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in the water.

Sources: acid rain, mining (note: in the Chicago region the pH of rivers, lakes and ponds is buffered by limestone bedrock)

Values:

0-4.0: Aquatic life is severely stressed.

4-4.5: Few fish and invertebrates can survive.

4.5-6.5: Acid-tolerant invertebrates and fish can survive.

5.0-9.0: Suitable for human consumption.

6.5-8.5: Suitable for most aquatic animals.

6.5-13: Suitable for most aquatic plants.

Temperature

Importance: too high a value will preclude cold water animals from living in the river, less oxygen can dissolve in water the higher its temperature, higher temperatures promote higher growth rates

Sources (of high temperatures): hot water discharges (particularly power plants), lack of shade

Values:

<13C: Suitable for cold-water species such as trout, mayflies, caddisflies and stoneflies.

13-20C: Suitable for some salmon, mayflies caddisflies, stoneflies and beetles.

20-25C: Suitable for most other fish, invertebrates and warm water species.

>25C: Lethal to trout, salmon, many aquatic insects and most cold water species.

Phosphates

Importance: promotes growth, excessive levels can lead to eutrophication and fish kills and reduction in biodiversity

Sources: fertilizers, detergents

Values:

0.005-0.05ppm: Typical of undisturbed forest streams.

<0.5ppm: Suitable for human consumption.

0.05-0.1ppm: May increase aquatic plant growth.

>0.1ppm: Likely to cause algal blooms.

1.0ppm: Approximate ideal upper limit for wastewater treatment plant effluent.

Nitrates

Importance: promotes growth, excessive levels can lead to eutrophication and fish kills and reduction in biodiversity

Sources: fertilizers

Values:

0.1ppm: Typical of undisturbed forest streams.

0.1-1.0ppm: May increase aquatic plant growth.

>1ppm: Likely to cause algal blooms.

<10ppm: Suitable for human consumption

<90ppm: No direct effect on fish



Turbidity and Total Solids

Importance: impedes breathing of animals with gills, impedes filter feeding, impedes sunlight that leads to a reduction in photosynthesis

Sources: erosion, organic material

Values: To sustain aquatic life, turbidity 10 day average should not exceed 25NTU/JTU and no reading should exceed 50NTU/JTU.

Fecal Coliform

Importance: is a bacteria that though not pathogenic itself, is an indicator for the presence of human feces and thus the potential for the presence of pathogens

Sources: leaky septic systems, combined sewer overflows

Values: To be safe for swimming there should be no more than 250 colonies/100 ml.

Procedure

Before the field trip

Make sure your students understand all the tests that they will be conducting in the field. Students should understand how the water quality indicators impact aquatic plants, aquatic animals and humans, as well as what some possible sources of these chemicals are. Friends of the Chicago has a lesson, *Water Quality Tests Explained*, that can help students with this. Feel free, however, to develop your own method.

Part of understanding water quality in the Chicago River necessitates understanding watersheds. A lesson that explores this is *What is a Watershed?* by Friends of the Chicago River. Both lessons are available at www.chicagoriver.org/education.

In addition, it is very helpful if students have the opportunity to practice using the water quality monitoring equipment before the field trip. Students can use the equipment in the classroom to test a nearby water body (such as a pond or puddle), tap water or water from a fish tank.

In thinking about conducting the field trip, you can decide to have students do a subset of the tests, to divide students into expert groups and have each group focus on two or three tests, or have all student groups complete all tests.

Another way to prepare students for their field trip is to have them develop hypotheses they can test at their field trip. Possibilities include hypotheses about the general water quality, about which of the parameters they think will be impaired, or how the Chicago River water quality compares to another water body.



Preparing for the field trip

For information on planning and organizing a field trip and for safety tips, visit our web site at www.chicagoriver.org/education, then click on field trips.

As with all field trips, students should be divided into small working groups. A group of four or five is ideal to ensure that everyone participates. Larger groups work best when students within the group are assigned specific tests to complete and share data with the larger group.

Review the water quality data sheets with students. Two different sheets are included here. One assumes students will be calculating Q values and an overall water quality index (recommended for more advanced high school students). The other does not include Q values. For information on how to use Q values and calculate an overall water quality index, please refer to *Field Manual for Water Quality Monitoring* by Mitchell and Stapp which can be borrowed from Friends of the Chicago River or purchased from Earthforce at www.earthforce.org/catalog.

The Field Trip

By the day of the field trip students should be well prepared and groups should know what their tasks are and how to use the equipment. Usually students only record their data on the day of the field trip. However, at some field trip sites tables and shelters are available and it is possible for students to begin their analysis on the day of the field trip.

After the Field Trip

If you are having students calculate Q values, they can do so after returning from the field trip. In all cases have students spend time analyzing their data. Students can look at statistical issues such as calculating means and deciding if there are outliers, they can examine if they disproved their hypotheses, and discuss their results in terms of what they have to say about the Chicago River's water quality. What tests showed the most impairment? What tests looked good? What does that mean for the plants and animals inhabiting the river and for the animals and people visiting the river?

As an extension, have students research ways they can reduce some of the problems they found. Encourage students to think of big scale solutions (such as policy initiatives) and small scale solutions (such as convincing their parents to buy dishwasher soap without phosphates).



Water Chemistry Data Sheet

School Name: _____

Site Location: _____

Date: _____ Time: _____

| Test | Expected Range | Equipment | Test Value | Q Value | Weighting Factor | Total |
|--|-----------------------------|-----------|--|---------|------------------|-------|
| pH | 6-8.5 | | | | 0.11 | |
| Phosphate (ppm or mg/l) | 0.1-2.5 ppm | | | | 0.1 | |
| Nitrate (ppm or mg/l) | 0.2-8 ppm | | | | 0.1 | |
| Dissolved Oxygen (concentration: ppm or mg/l, percent saturation: %) | 1-12 ppm | | Concentration: % Saturation: | | 0.17 | |
| Biological Oxygen Demand (ppm or mg/l) | 0.05-19 ppm | | | | 0.11 | |
| Temperature (°C) | Difference: < 3 °C | | Site 1: Site 2 Difference: | | 0.1 | |
| Turbidity (cm) | 2-140cm | | | | 0.08 | |
| Total Solids (mg/l) | 200-2800 mg/l | | | | 0.07 | |
| Fecal Coliform (E.coli colonies/100ml) | 50 – 100,000 colonies/100ml | | | | 0.16 | |

Overall Water Quality Score

Water Chemistry Data Sheet

School Name: _____

Site Location: _____

Date: _____ Time: _____

| Test | Expected Range | Test Value | Rank or Description (if using GREEN kit) |
|--|-----------------------------|--|--|
| pH | 6-8.5 | | |
| Phosphate (ppm or mg/l) | 0.1-2.5 ppm | | |
| Nitrate (ppm or mg/l) | 0.2-8 ppm | | |
| Dissolved Oxygen (concentration: ppm or mg/l, percent saturation: %) | 1-12 ppm | Concentration: % Saturation: | |
| Biological Oxygen Demand (ppm or mg/l) | 0.05-19 ppm | | |
| Temperature (°C) | Difference: < 3 °C | Site 1: Site 2 Difference: | |
| Turbidity (cm) | 2-140cm | | |
| Total Solids (mg/l) | 200-2800 mg/l | | |
| Fecal Coliform (E.coli colonies/100ml) | 50 – 100,000 colonies/100ml | | |