BIOBUGS Urban Ecology: Watersheds and Aquatic Ecology
Instructor Prep Notes

Overview:

In this lab we will introduce students to the concept of watersheds and aquatic ecology. This lab involves a field component during which students will test water quality, assess the site for human impacts, and search for aquatic macroinvertebrates. They will use all the information they gather to assess the health of the Muddy River and extrapolate about the health of the Charles River and Boston Harbor, based on what they have learned about watersheds.

Watersheds are areas of land that drain into a body of water. Every body of water has a watershed: streams, rivers, ponds, lakes, harbors, bays, and ocean basins. As rain water passes over land masses, draining to the lowest elevation, it carries with it loose top soil, debris, litter, and chemicals that have been spilled (like oil, gasoline) or deliberately placed onto the land (such as fertilizers and pesticides). This is called "run-off" and can have negative impacts on aquatic wildlife. This can have ecological and economic impacts, depending on the organisms that are impacted. For example, sewage run-off in coastal areas can result in the closing of beaches in the summer time and prohibition of fishing activities.

Massachusetts Educational Standards for Biology

Biology

- 1. The Chemistry of Life
- 1.3 Explain the role of enzymes as catalysts that lower the activation energy of biochemical reactions. Identify factors, such as pH and temperature, which have an effect on enzymes.
- 6. Ecology
    - 6.2 Analyze changes in population size and biodiversity that result from the following: natural causes, changes in climate, human activity, and the introduction of invasive, non-native species.
    - 6.4 Explain how water, carbon, and nitrogen cycle between abiotic resources and organic matter in an ecosystem, and how oxygen cycles through photosynthesis and respiration.

Scientific Inquiry Skills

- SIS1. Make observations, raise questions, and formulate hypotheses.
- SIS3. Analyze and interpret results of scientific investigations.
- SIS4. Communicate and apply the results of scientific investigations.

Mathematical Skills

- Construct and use tables and graphs to interpret data sets.
- Measure with accuracy and precision.
- Use common prefixes such as *milli-*, *centi-*, and *kilo-*.
- Use scientific notation, where appropriate.

Materials (for 24 students; split into 8 teams of 3 or 6 teams of 4):

1 student packet and clipboard per student
Powerpoint
6-8 dip nets
6-8 white basins (borrow from Intro Bio Labs)
small Petri dishes to isolate aquatic macroinvertebrates (borrow from Intro Bio Labs)
plastic liquid droppers or pipettes for water sample gathering and isolation of small inverterbrates (borrow from Intro Bio Labs)
gloves (borrow from Intro Bio Labs)
water quality test kits: pH, nitrate, dissolved oxygen
6-8 aquatic field guides
6-8 Quick Reference Guide to Aquatic Invertebrates

6-8 “Invasive plant species of the Fens” guides
1 Charles River Case Study worksheet per student
waste container for water quality station
trash bag for gloves
hand sanitizer
Optional: 1 Extension Activity packet per student and teacher

Time table

Approx. time	**Activity**	**Detail**
9:00-9:10	Welcome the class and go over safety considerations	Introduce all grad students Safety considerations for the field
9:10-9:30	Mini-lesson on watersheds and ecological assessment	Powerpoint; students should takes notes on background info
9:30-9:40	Distribution of field equipment and bathroom break	1 per group (net, basin, Pondwatcher’s Guide, Invasives Guide), 1 per student (packet, clipboard, pair of gloves)
9:40-9:55	Walk to Riverway Park in the Fens	Exit the building from the second floor Beacon Street exit. Take a right onto Beacon (away from Kenmore Square). Take a left at the first traffic light onto Park Drive. You will cross a bridge that traverses the “D” line subway. After this bridge you will see a small brick building on your right. The Riverway is not marked but it is a paved pathway on the right after that small brick building. Walk down that pathway until to you come to the second or third open grassy area. The water should be easily accessible so that the students can search for water invertebrates.
9:55-10:00	Brief explanation of data collection and stations	Set up an area for water quality testing (using the kits). Designate another area for dipping nets into the water to search for macroinvertebrates. A third station requires the students to assess the entire study site. There is a table for data collection for each station in the student packet.
10:00-11	Data collection	Split the teams between the three stations. Have them rotate through; 20 minutes per station.
11:00-11:15	Return to lab	You may want to allow for a bathroom break, or at least have them wash their hands.
11:15-11:20	All groups share water quality and macroinvertebrates data.	Share the raw data (there is a slide for this in the powerpoint).
11:20-11:30	Work within team to analyze data and	Student teams will use the compiled raw

	answer questions.	data to answer the analysis questions in their packets. You should also give them the aquatic inverts pollution tolerance guide and the sheet with water quality EPA guidelines.
11:30-11:45	Group discussion of analysis	Go over the questions with the class.
11:45-12:00	Wrap-up and Evaluations	The last two slides in the Powerpoint are a report card for the Charles River (tie-in with their predictions from the analysis) and suggestions for minimizing human impacts on watersheds. Lastly, handout the student and teacher evaluations
Extension activity	Charles River Long-term water quality (if time permits at the end, or for the teacher to take away for use back in the classroom)	Have the students analyze the long-term nitrates and *E. coli* data and complete the questions.

Water quality test kit instructions:

pH Wide Range: (LaMotte test kit #5890; refills available online at www.acornnaturalist.com)
1. Fill the test tube to the 10mL line with water that you are testing.
2. Add one pH Wide Range TesTab.
3. Cap the tube and mix until the tablet has dissolved.
4. Compare the color of the sample to the pH Color Chart. Record the result as pH.

Nitrate-Nitrogen: (LaMotte test kit #3354; refills available online at www.acornnaturalist.com)
1. Fill a test tube to the 5 mL line with water that you are testing.
2. Add one Nitrate #1 Tablet.
3. Cap and mix until tablet dissolves.
4. Add one Nitrate #2 CTA Tablet.
5. Cap and mix until tablet dissolves.
6. Wait 5 minutes.
7. Insert Nitrate-Nitrogen Octa-Slide Bar into the Octa-Slide Viewer.
8. Insert test tube into Octa-Slide viewer.
9. Match the sample color to a color standard. Record as ppm (parts per million) Nitrate-Nitrogen.

Dissolved Oxygen: (LaMotte test kit #5860; refills available at www.coleparmer.com)
1. Collection and fixation of water sample
    a. To avoid contamination, rinse the Water Sampling Bottle with the water to be sampled.
    b. Tightly cap the bottle and submerge completely in the water to be tested. Then remove the cap and allow the bottle to fill.
    c. Tap the sides of the bottle while underwater to get rid of any air bubbles in the bottle. Then replace the cap while the bottle is still submerged.
    d. To fix the sample, add 8 drops of Manganous Sulfate Solution and 8 drops of Alkaline Potassium Iodide Azide. Cap and mix by inverting several times. A precipitate will form; allow the precipitate to settle to below the shoulder of the bottle before moving on.
    e. Add 8 drops of Sulfuric Acid 1:1. Cap and mix gently until the precipitate has dissolved. Color should develop into a clear-yellow to brownish-orange color.
    Sample is now fixed, so contact with the air will not affect the oxygen reading.

2. Titration test for dissolved oxygen
    a. Fill the titration tube to the 20mL line with the fixed sample and then cap.
    b. Fill the Direct Reading Titrator with Sodium Thiosulfate 0.025N. Insert the Titrator into the center hole of the titration tube cap. Gently swirl the tube and slowly press the plunger to titrate until the yellow-brown color is reduced to a very faint yellow. NOTE: If the color is already a very faint yellow before titrating, skip to the next step.
    c. Remove the Titrator and cap. DO NOT disturb the Titrator plunger. Add 8 drops of Starch Indicator Solution. Sample should turn blue.
    d. Replace the cap and Titrator. Continue titrating until the blue color disappears. Read the test result where the plunger disappears. Record as ppm dissolved oxygen.

Notes:
This lab is meant to have the field component. It is possible to do this lab completely inside if you pre-collect aquatic invertebrates for the students or purchase preserved samples from a collector or natural science catalog. You would also need to pre-collect water samples. That would involve fixing a sample with the dissolved oxygen kit. The kit does have directions for that. If you choose this route, you may also want to plan on completing the extension activity as part of the lab, as you will have time to fill that would have been taken up by walking to the Fens.

Two groups can be at the water quality testing station at a time. Plan accordingly depending on the size of the class. The macroinvertebrate and site description stations can accommodate multiple groups at a time, just split up the field guides, nets, and basins accordingly. The dissolved oxygen test kit takes much longer than the other two tests (instructors should practice this test ahead of time). For time management at the water quality testing station, have teams split up. Half of each team should pair up with half of the other team to carry out the dissolved oxygen test. All students should observe the titration. While half of each team is working on the dissolved oxygen, the other halves of the teams can do the pH and nitrates tests.

Students should wear gloves when handling the water at the Fens, during both the water quality testing and the macroinvertebrates sampling. Before leaving the field site, you should make sure all gloves are in the trash bag and that students have used hand sanitizer as a precaution. Have students wash their hands after they return from the field.

Teachers should be told ahead of time that this is an outdoor lab. Students should wear clothes and shoes that can get wet and dirty.