Activity Guide

Classroom by the Concord

TSONGAS INDUSTRIAL HISTORY CENTER

University of Massachusetts Lowell
Graduate School of Education

Lowell National Historical Park

Classroom by the Concord

Program Description

Classroom by the Concord is a hands-on exploration of the effects of the Industrial Revolution on water resources. Lowell National Historical Park and the Concord River will be the focus of our exploration. The program is comprised of a 90-minute workshop and a 90-minute tour, with lunch in between. Two classes of no more than 32 students each can be accommodated, with one class doing the workshop first and the tour after lunch, and the other class doing the tour first and the workshop after lunch.

The workshop at the Tsongas Center engages students in activities that address how contamination affects groundwater and surface water and, in turn, impacts the quality of life in our communities. Students create cup-sized models that represent land along the Concord River. The students then “contaminate” their land and water to learn how contamination moves through both.

The tour component takes students out to the Concord River Greenway, a preserved area of land adjacent to the river. There they assess the health of the river using a variety of water quality tests. They also investigate human alteration and regulation of the river and what this has meant to the watershed’s flora and fauna.

Lunch will be limited to half an hour between the tour and workshop. Each participant should bring his or her own lunch and beverage. No food or beverages are available for sale at the Center.

Please advise all participants to dress properly for the cool and wet conditions on the tour. All-weather shoes with good traction, outdoor clothing, and a light jacket or covering are appropriate. The program is “rain or shine,” and the tour will be canceled only in the event of bad weather conditions.

Theme

The Industrial Revolution was a defining era in American history. All that we consider "modern," in technology, politics, art, culture, the nature of work, or the environment around us, was shaped by the period.

During the nineteenth century, industrial centers began to spring up along rivers and streams across northeastern America. The waterways of New England were dammed, controlled, and put to work to produce power to run machinery and make products that would be sold across the nation and around the world. As the factories flourished and demanded more workers, cities grew to accommodate the growing needs of their expanding populations. Manufacturing and urbanization together created huge amounts of industrial and domestic wastes that were dumped into the waterways and poured out onto the ground. These wastes turned the once-pristine surface waters into something close to sewer basins. In addition, many contaminants seeped into the groundwater. The pollution of these water resources had a profound effect on living things, including plants, animals, and the people who relied on them for fresh water.

From its pastoral beginnings in the once tranquil farmland west of Boston, the Concord River flows northward on a meandering course that eventually brings it to Lowell. As it enters the city it becomes considerably more lively, tumbling over three waterfalls before it finally joins the Merrimack River on the city's east side. The power in these falls attracted early mills, many of which predate the mills that used the Merrimack River's much greater, but less easily harnessed, potential. Throughout the 19^{th} and early 20^{th} centuries, the Concord in Lowell was saturated with industrialization and subjected to the full measure of environmental degradation that historically plagued the "workhorse" rivers of New England. By the 1880s, and into the twentieth century, the Concord River was one of the most polluted rivers in Massachusetts. Only in recent decades has progress been made toward rectifying this situation, thanks to federal and state legislation, environmental research and education programs, and the concern of ordinary citizens. The **Classroom by the Concord** program explores the story of the Concord: its growth as an industrial river, its demise at human hands, and its rebirth as human hands seek to restore it.

Program Objectives

After participating in **Classroom by the Concord** and using the activities in this guide, students will be able to:

- Explain the difference between surface water and groundwater and how the two are connected.
- Describe how a food web is constructed and what information it gives us.
- Explain how contamination can affect the quality of water and the health of living things that depend on it.
- Describe how, historically, the actions of Lowell's factories had consequences for the environment and what some of those consequences were.
- Describe the role of federal and state agencies, including the National Parks, as stewards of the environment, and how students, as citizens, can be stewards themselves.

Background: The Industrial Revolution and the Environment

The Industrial Revolution was not only a turning point in the economic development of the United States. It also marked a change in the relationship between people and their environment. With the development of technologies to harness waterpower and the evolution of machinery for mass production, home production and cottage industries were replaced by the integrated factory system. Factories required expansive areas of land for building sites, huge amounts of raw materials, significant power sources, a large work force, and a complicated infrastructure of support systems (transportation, waste disposal, etc.).

Many of the old mill buildings are now abandoned. They are silent testaments to a period of productivity and economic expansion that began in the nineteenth century and continued into the early twentieth. They are also reminders of how industrial expansion impacted the environment, particularly water resources. For instance, textile corporations in such places as Lowell dammed the Concord and Merrimack Rivers and dug miles of canals to capture the water and bring it to the mills. These modifications affected not only the physical state of the river, but the riparian flora and fauna as well. The dams were one of the main causes of extinction of spawning salmon, shad, and herring from the Concord.

Textile corporations and related industries not only altered the river's flow but also became major polluters of the watershed. They discharged dyes, bleaches, soaps, and solvents into the river. Organic waste from cleaning the raw cotton was dumped into the canals and river. "Suint," the greasy coating covering wool fibers, was scoured from the fleece with caustic solvents that often were discharged directly into the waterways. In the 1890s the textile industry in Lowell used and discharged approximately 40,000,000 gallons of process water per day.

Even by the middle of the nineteenth century, the inherent contradiction between using the river as a municipal and industrial sewer and the river as a source of drinking water had become evident. Waterborne disease broke out on a recurring basis and was a constant threat to the population. Scientists, physicians, and government officials were demanding protection for water resources. Few heeded their demands since it was more convenient and cheaper to dump the waste into the waterways and landfills than it was to treat and clean the municipal and industrial sewerage. Although awareness and acceptance of germ theory was growing, the science of filtering water and making it potable was in its infancy. So, in 1878, after several studies on pollution of the Merrimack River and its tributaries, the Massachusetts State Board of Health (MSBH) proposed legislation to prevent the discharge of municipal and industrial waste within 20 miles of a municipal water supply. The law was neither enforceable nor effective as it exempted the lower Concord, Merrimack, and Connecticut rivers from any regulation. These rivers, too valuable to industry to warrant protection, continued to languish for nearly a century before action was taken in their behalf. The following paragraph is an excerpt from the report of the Massachusetts State Board of Health for 1913, detailing the condition of the Concord River in Lowell. It provides a vivid example of the kind of abuse the rivers of New England typically suffered for so many decades:

> Within the limits of the city of Lowell, the Concord River is polluted by large quantities of sewage and by manufacturing wastes discharged into the stream from mills located along the river and its main tributary, Hales Brook [or River Meadow Brook]. Just below the point where the river enters the city . . . it receives the flow of two small sewers and considerable foul drainage from the population in this section . . .
>
> The river also receives considerable pollution from manufacturing wastes, the most serious of which is that from the processes of wool scouring and tanning, although considerable pollution is no doubt also caused by wastes from cloth washing, dyeing, etc. . . . At the works of the United States Bunting Company, also on Hales Brook, the stream is polluted by the sewage from about 500 operatives and the foul waste resulting from the scouring of 1,500,000 pounds of wool per year. The Lowell Bleachery, located on Hales Brook, discharges into the stream each day the sewage from about 450 operatives and also about 2,160,000 gallons of water used in bleaching and washing cloth.
>
> From the Massachusetts State Board of Health, *Report of the State Board of Health Upon the Sanitary Condition of the Merrimack River* (1913).

The Clean Water Act of 1972 marked a turning point for the nation's polluted rivers. The legislation initiated efforts not only to clean the rivers but also to prevent and monitor pollution that enters the watershed. Today a renewed interest in reusing old industrial sites and buildings is contributing to the clean-up and protection of our water. Developers are renovating old mills that are then used for housing, office space, and new industry. Contaminated areas are being remediated. New businesses, parks, and sports facilities are replacing old, abandoned buildings and industrial sites. Utilizing these sites instead of building upon undeveloped land reduces urban sprawl, aids in revitalizing cities, and helps to protect watershed areas.

The land on either bank of the Concord River at Lawrence Street is an example of the effects of past and present-day human use. Trees, bushes, and grass share a narrow strip between the water and developed land with overhead power lines, much of the river bank soil is backfill, and much of the river itself is channelized by stone and concrete retaining walls. And yet, here among some of the most densely settled and urbanized census blocks in the state, natural processes continue to function. The area is once again rich with bird- and plant-life, and anadromous fish are showing a tentative willingness to return. But the work is not done. The area is still in the midst of a heavy human presence, and remains vulnerable to human action.*

**Parts of this paragraph were taken, with permission, from the Mass Audubon Ecological Inventory of the Concord River in Lowell.*

Pre-Visit Activities

1. Groundwater on the Move

Often, students have difficulty with the concept of groundwater, largely because they can never see it. Groundwater is, well, water that is under the ground! Rainwater seeps down through layers of earth's crust and enters aquifers, underground storage areas where water flows between rocks, gravel, and grains of sand. The water is pulled down by gravity until it reaches bedrock, or some barrier it cannot cross. For hundreds of years people have accessed this water by digging wells and letting down buckets to collect the water. With the coming of the Industrial Revolution and the use of electricity, people also began installing electric pumps to pull water up through pipes.

If this water is underground, how can it be affected by pollution that people are creating and depositing on the surface? This activity will help your students find out. It can be done in lab groups, or as a demonstration.

For each working group of students, you will need:

- A clear plastic bin, about the size of a shoebox, no lid
- A bag of ice cubes.
- A packet of Kool-Aid powder, or another brightly-colored drink mix
- A pitcher of water (your "rain")
- A turkey baster (long plastic tube with a bulb on one end)

Directions:

1. Fill the bin with ice cubes, almost to the top. The ice cubes represent rocks and pebbles and grains of sand in the earth's crust.

2. Now, make it "rain." Slowly pour enough water into the ice so that it is about one inch deep in the bottom of the bin. Watch as you pour, and you will see the water trickling down between the "rocks" in the bin until it reaches the "bedrock," in this case the bottom of the bin. You have created an aquifer!

3. Squeeze the bulb of the turkey baster. Insert the other end of the baster down into the aquifer in the bin. Slowly release the bulb. What happens to the water in the aquifer? You have "pumped" water out of the aquifer for people to use!

4. Now, you are a factory that is making textiles. You are generating wastes that are being dumped on the ground. Open the Kool-Aid pack and sprinkle some of the powder on the ice cubes; this is your pollution.

5. Make it "rain" again. Slowly pour more water over the ice cubes and see what happens to the pollution. Does it stay in place? Does it move? If yes, how does it move and where does it go?

6. Now, try using the turkey baster again to pump up water for people to use. What happens to the water in the aquifer that people used to rely on for drinking, cooking, and other uses?

Questions for Discussion:

1. How can groundwater get contaminated?
2. Why are some polluters unaware of the problem of groundwater contamination?
3. How does contaminated groundwater cause problems for people?
4. How could we change our behavior to help protect our aquifers from getting contaminated?

2. Food Web Activity

The phrase "food web" is meant to convey the concept that all living things, plant and animal, are interdependent. One organism feeds upon another, and in turn becomes food for a third. The population levels of these organisms are regulated by a number of factors that nature, in the absence of human interference, keeps in balance. At the base of every food web are the plants, the only living things that can manufacture food from the constant stream of incoming energy we know as sunlight. Upon this foundation, every ecological system is built and maintained. The following activity is designed to help students understand this food web concept by analyzing information about certain animals native to the Concord River watershed.

Directions:

1. "The Dinner Table," below, is a table of information about various organisms that inhabit the Concord River area. It contains three columns: the name of the organism, the "What It Eats" column, and the "What Eats It" column. Pass out a copy of **"The Dinner Table"** page to each student.

2. Below is also a blank copy of the **"Concord River Food Web"** page. **The arrows indicate what is eaten by what, with the tail of the arrow at the "eaten" (prey) and the head of the**

arrow at the "eater" (predator). The "Plants" entry has been inserted to help students get started. Pass out a copy of the blank food web to each student.

3. Instruct students to study the information in "**The Dinner Table,"** determine the place of each organism in the blank food web, and write that organism's name in the proper location in the web. Note**: Each organism has a single place in the web where only it can fit.** (An answer key is also provided.)

Questions:

1. Consider what would happen if the food web were disturbed for some reason. For example, suppose a virus killed off all the mice. What would be the consequences for the other organisms in the food web?

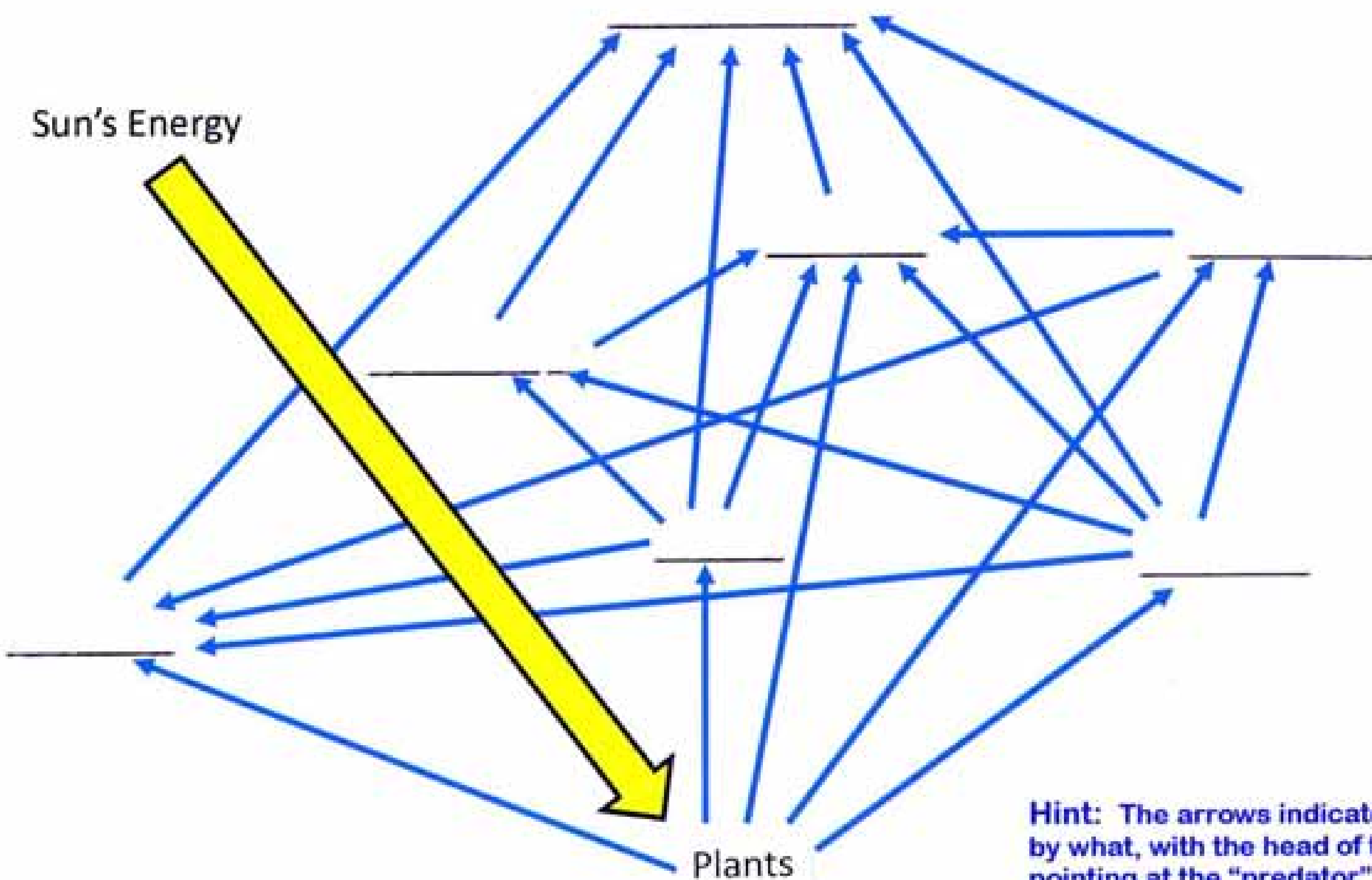
2. What might happen if human beings did something to upset the food web? For example, suppose people decided to shoot the red-tailed hawks because they were afraid the birds might attack family pets kept outdoors? What would be the consequences for the food web?

“The Dinner Table”

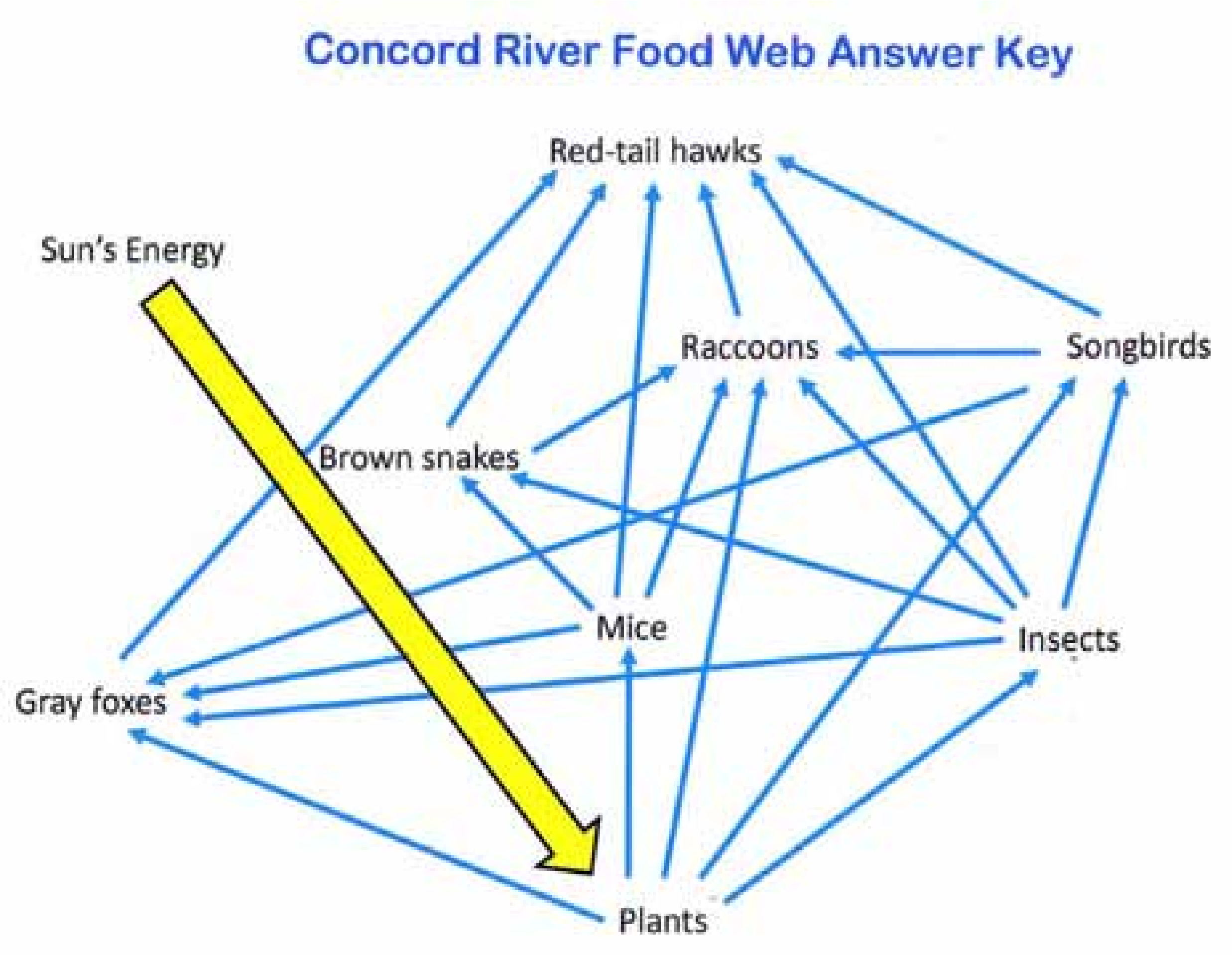
Name of Organism	What It Eats	What Eats It
Plants	Sun’s Energy	Gray Foxes Mice Raccoons Insects Songbirds
Insects	Plants	Songbirds Gray Foxes Brown Snakes Raccoons Red-tailed Hawks
Mice	Plants	Gray Foxes Brown Snakes Raccoons Red-tailed Hawks
Songbirds	Plants Insects	Gray Foxes Raccoons Red-tailed Hawks
Brown Snakes	Mice Insects	Raccoons Red-tailed Hawks
Gray Foxes	Plants Insects Mice Songbirds	Red-tailed Hawks
Raccoons	Brown Snakes Mice Plants Insects Songbirds	Red-tailed Hawks
Red-tailed Hawks	Mice Gray Foxes Brown Snakes Raccoons Insects Songbirds	

Concord River Food Web

Directions: Use the information from "The Dinner Table" to fill in the blanks and construct your Food Web. Remember, each organism can fit in only ONE location!



Hint: The arrows indicate what is eaten by what, with the head of the arrow pointing at the "predator" and the tail of the arrow, at the "prey." The "Plants" give you a head start!


Concord River Food Web Answer Key
Red-tail hawks
Sun's Energy
Raccoons
Songbirds
Brown snakes
Mice
Insects
Gray foxes
Plants

3. Water Testing Preparation

During their visit to the Concord River Greenway, your students will be doing water quality testing to determine the health of the river. They will be testing the following parameters:

- Dissolved Oxygen
- pH
- Turbidity
- Temperature

These parameters are four of the nine that are typically used by scientists to determine the **Water Quality Index**, or WQI, of a body of water. For more detailed information on the type and meaning of the tests, please refer to the Appendix at the end of this Activity Guide.

Dissolved Oxygen

Most living things require oxygen to survive. How do fish, living underwater, get the oxygen they need? Oxygen is dissolved in water and can be absorbed by the gill structure of the fish. Most water contains some level of dissolved oxygen, which enters from the atmosphere and from the action of plants as they absorb sunlight and photosynthesize, releasing the gas in the process. The amount of oxygen available is dependent on several factors, including the temperature of the water (colder water holds more oxygen) and the level of pollutants. Below are some simple activities that you can do with your class to help students grasp the concept of a gas dissolved in a liquid, and the importance of dissolved oxygen.

Activities

- To see evidence of a gas dissolved in water, look at a clear bottle of carbonated beverage. Are any bubbles visible? Shake the bottle gently. How does the appearance of the liquid change?
- Pour the liquid into a glass and put your hand over the top. What can you feel? The bubbles from the liquid are bursting against your hand. This is the release of carbon dioxide in the liquid--that is what gives soda pop its "fizz."
- To see the release of oxygen from water, fill a clear glass with hot water. Let the water stand for a few minutes. Observe the bubbles that collect inside the glass. What are the bubbles filled with? Where did it come from?
- Boil water in a pan and watch the air bubbles collect along the sides of the pan. As the water approaches boiling, the bubbles will start to move and pop at the surface. Emphasize that practically all the air would be driven out of the water if it were boiled a short time.
- If you have a fish tank, have the students observe the gill movement of the fish. Fish, like people, need air and they collect it through their gills underwater. When fish continually stay near the surface or break the surface of the water, that is an indication that there is not enough air (oxygen) in the water.

pH

Different levels of acidity or alkalinity are tested in terms of pH. The pH scale goes from 0 to 14. A neutral solution has a pH of 7; one that has a pH greater that 7 is basic; and one that has a pH less than 7 is acidic. The scale is a ‘power-of-ten” scale: starting with 7, each number down from 7 is a ten-fold increase in acidity, while each number up from 7 is a ten-fold increase in alkalinity (or “basicness”). Normal rainfall has a pH of 5.6, with damaging effects occurring for any level under that. Here are some possible consequences of a pH that is too low or too high:

- For Salmon and Trout, failure to reproduce (in water of pH below 5.5)
- Death of fish, aquatic plants, and microorganisms in lakes and streams
- Damage to buildings, statues, car finishes

Activity

Gather a variety of liquids, i.e., tap water, cola, vinegar, lemon juice, rain water, milk, etc. Have the students hypothesize whether they are acid or base. Using simple pH testing strips available at any pet or pool supply store, test each liquid and rank them according to their pH value. Are there any surprises?

Set up a simple experiment using plants. Water one with water and designate it as the "control." Water the other plants with solutions containing increasing amounts of vinegar. What happens to the plant? Some plants actually thrive in acid environments and will tolerate acidic water or soil. Most aquatic plants and animals, however, need a stable pH environment to survive.

Turbidity

Turbidity refers to the amount of solids suspended in the water. The murkier the water, the more "turbid" we say it is. Increased turbidity affects water life in the following ways:

- The more solids there are, the less sunlight can be transmitted to the plant life below. Plants give off oxygen so the amount of oxygen is reduced.
- Water becomes warmer as the solids absorb heat from the sunlight. Warmer water holds less oxygen.
- Increased sediments in the water can coat fish gills, cover eggs on the bottom, and affect growth of aquatic life.
- Sediments fill spaces in rocks on the bottom reducing suitable places for small aquatic life to live and breed.

The amount of light that reaches below the surface can be measured by a turbidity test using a black and white disk called a "Secchi disk" (sek-key). The disk is lowered into the water on a measured rope. When the disk is no longer visible, the depth is marked on the rope, and the disk is pulled in. A lower reading indicates more turbid water. As data are collected on turbidity, patterns may be seen. In the spring there may be more sediment in the water due to spring run-off and increased agitation of fast moving water. If a foreign substance is dumped into the river (for instance, sawdust), that would result in a lower turbidity measurement.

Activity

To demonstrate turbidity, pour a glass of whole milk into a clear glass and shine a light through it. Is the light transmitted? The fat particles in milk prevent light from shining through. Now dilute the milk with water and shine the light through it again. The decreased number of suspended fat particles allows the light to be transmitted.

Temperature

As water grows warmer, it holds less oxygen. Certain species prefer different temperatures of water--Atlantic salmon prefer colder water than largemouth bass, for example. The impact on their metabolic rate is most notable. Generally speaking, the metabolic rate doubles with each increase of 10 degrees Celsius. Such an increase accelerates the need for oxygen as the animals' respiration rate rises.

Temperature is monitored because it tells us about what could be happening below the surface, the amount, health, and types of species thriving there.

Activity

Taking the temperature of water is a straightforward procedure. Obtain a thermometer (in Celsius, Fahrenheit or both depending upon what scale you want). Some thermometers are available from science supply companies that have a ring at the top for attaching a string. Suspend the thermometer in the water until it is just covered by the water. Then wait two minutes for the reading to stabilize before recording the data.

Have your students practice taking water temperatures of different waters in your school. If you wish to have them practice conversion between Fahrenheit and Celsius, the formulae are:

$$°C = (°F - 32) \times 5/9$$

$$°F = (°C \times 9/5) + 32$$

Post-Visit Activities

1. Bioaccumulation Activity

Because of contamination from industrial and domestic sources over many decades, toxic substances including heavy metals have gradually made their way into the food web, stored cumulatively in the tissues of creatures as they prey on each other. This activity demonstrates how mercury, one of the most toxic, accumulates in the food web, to the point where it becomes dangerous to people.

The web (see **Bioaccumulation Activity Sheet 1**, next page) is set up in a linear fashion from the alga to the human who is fishing. The arrows indicate the relationship between food and consumer. Under the alga are ten Hg (mercury) symbols that represent ten hypothetical "units" of mercury contamination absorbed by the alga before it is consumed by the paramecium.

The **paramecium** consumes ten **algae.** The **scud** then consumes ten paramecia. The **water boatman** eats ten **scuds**, the **minnow** preys upon ten **water boatmen**, the **trout** consumes ten **minnows**, and the **person** fishing eats ten **trout**.

Each time ten "prey" are consumed, the amount of mercury contamination accumulates by a factor of ten. Therefore each paramecium will then have 100 "units" of contamination before it is eaten by the scud. The scud eats ten paramecia and will have 1000 "units" before it is eaten by a water boatman. The water boatman will eat ten scuds and contain 10,000 "units" of mercury before it is preyed upon. The minnow will eat ten water boatmen and accumulate 100,000 "units" of contamination before the trout eats it. Ten minnows are eaten by the trout that now has 1,000,000 "units" of mercury. The person fishing eats ten trout and so ends up consuming a total of 10,000,000 "units" of mercury contamination.

Directions:

1. Pass out copies of the two **Bioaccumulation Activity Sheets** to each student.

2. Have them calculate how many mercury units end up in each organism.

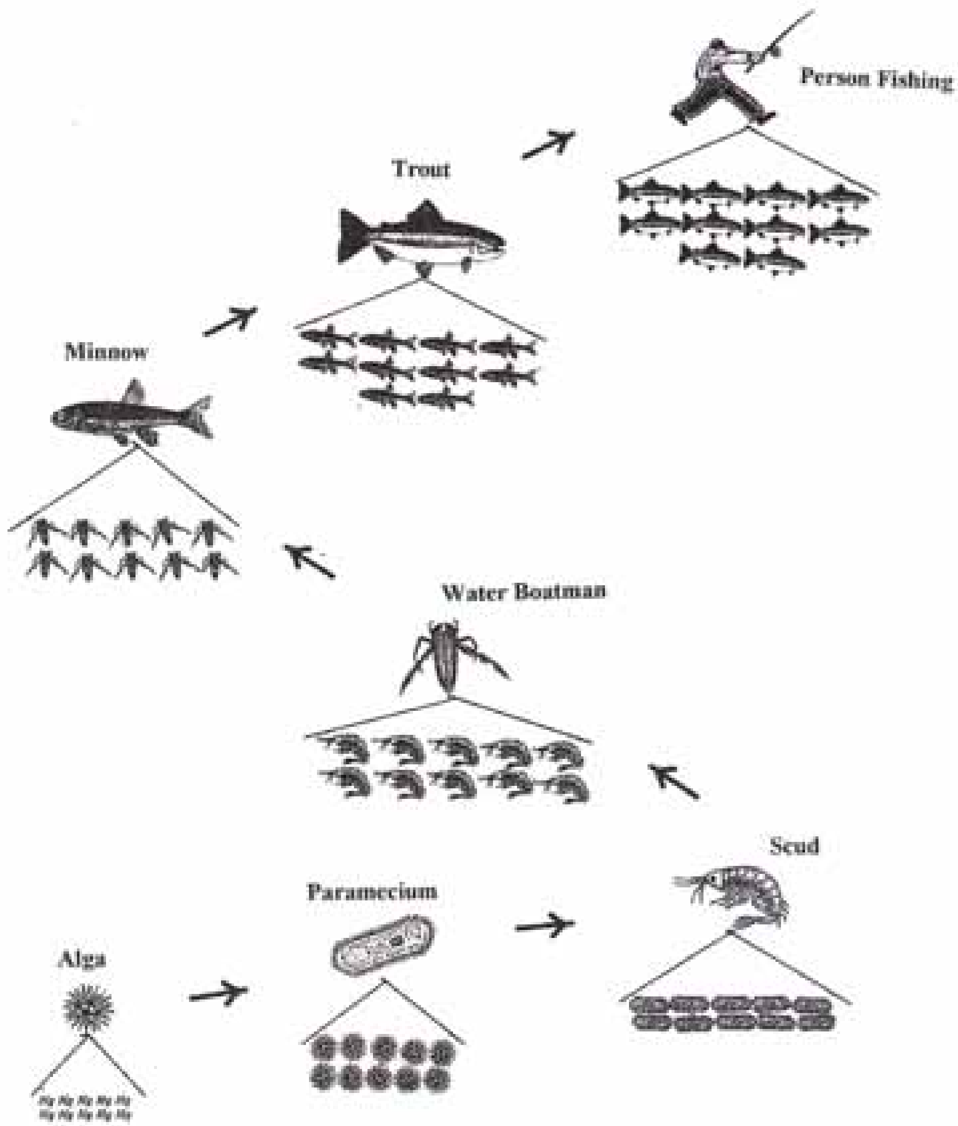
3. Discuss the accumulation of mercury in the levels of the food web and the significance of this, especially for humans as major consumers at the top of the web.

In Massachusetts, every body of fresh water has a "fish consumption advisory"*, a warning against consumption of particular fish that have been found to be contaminated. This includes the Concord River. Some places have an advisory for several species of fish and/or for several types of contamination. Mercury is one of the main contaminants that restrict the consumption of fish in the commonwealth.

Have your students do a web search to find out the sources of mercury and other contaminants in the fish in Massachusetts and wider New England.

*See:
www.mass.gov/Eeohhs2/docs/dph/environmental/exposure/fish_consumption_advisory_list.pdf

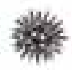
Bioaccumulation Activity Sheet 1
(Note: "Hg" is the chemical symbol for mercury.)



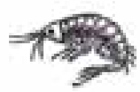
Bioaccumulation Activity Sheet 2

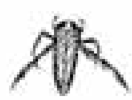
How many units of mercury end up in each member of the food web?

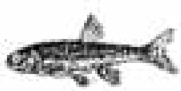
Calculate and fill in the missing numbers:

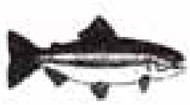
The  **contains __________________ units of mercury.**

The  **contains __________________ units of mercury.**

The  **contains __________________ units of mercury.**

The  **contains __________________ units of mercury.**

The  **contains __________________ units of mercury.**

The  **contains __________________ units of mercury.**

The  **contains __________________ units of mercury.**

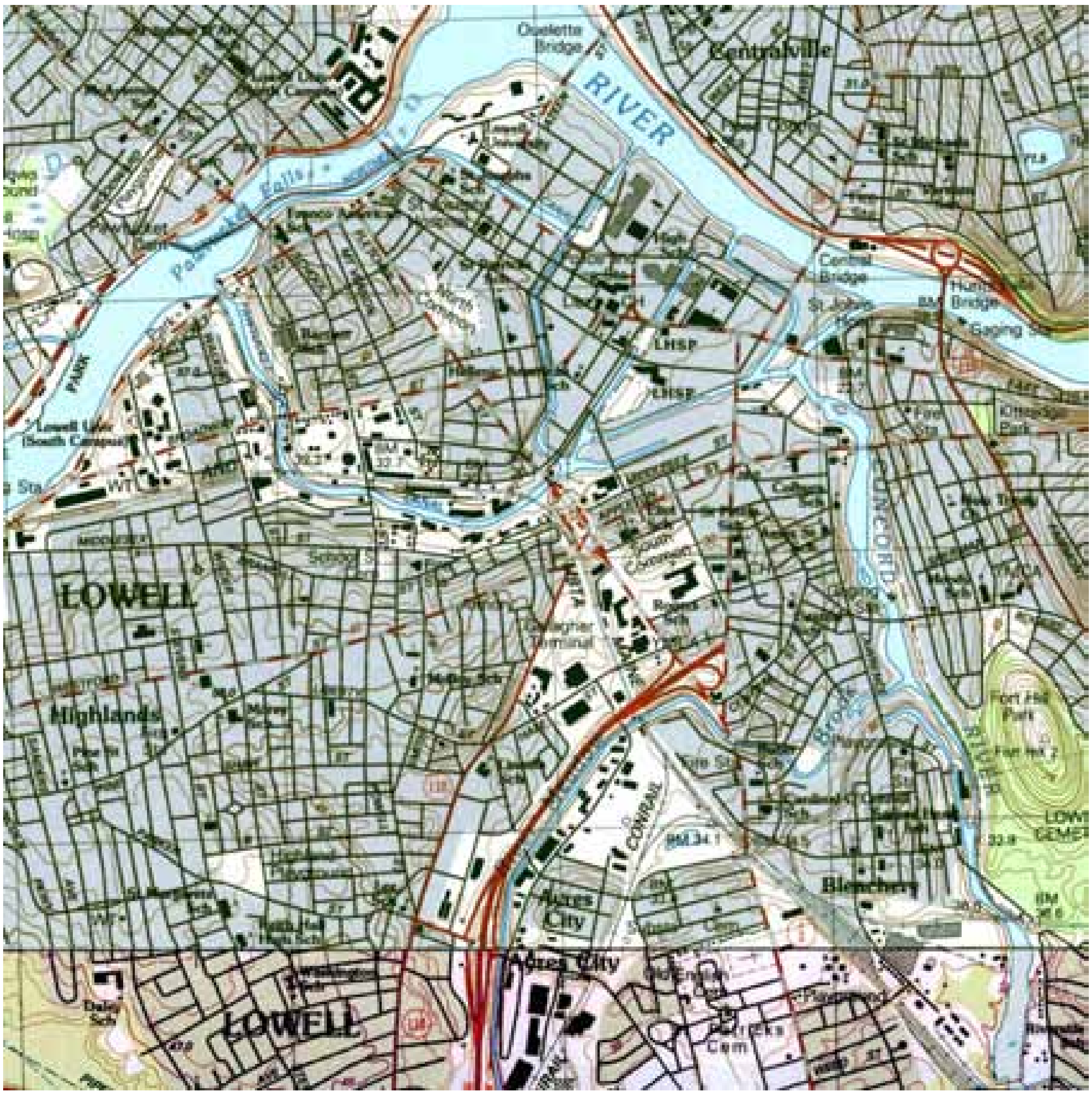
How does mercury make its way through the food web?

Since mercury is toxic, what might be the risk to the person fishing?

2. Exploring the Concord River in Lowell Using Topographic Maps

For Teachers: Maps can be very useful tools for uncovering information about past and present uses of land and water as well as the effects of these uses. Below is a topographic map of the Concord River area in Lowell. Print out copies of the map (enlargement may help), have your students analyze it, and answer the questions that follow. This may work best as a small-group activity.

Topographic Map of the Concord River Area in Lowell and North Billerica, MA



For Students: Before you answer the questions below, locate the Concord River on your map. It is flowing from the bottom of the map towards the top. Find "St. John's Hospital", which marks the point at which it enters the Merrimack River. Now, look at the overall map and notice that, unlike regular street maps, this *topographic* map has many curvy brown lines on it, indicating the *contour* of the land (high spots, low spots). Using this information, and the knowledge that water always flows *downhill*, we can investigate the health of the Concord River and its ecosystem.

Questions:

1. What kinds of human activity are going on along the banks of the Concord?
2. Look very carefully at the Concord River. Can you find the light-brown contour lines going across the river that indicate a change in elevation? What natural feature in the river corresponds with those lines?
3. Now look at the land along the riverbank. What clues on the map suggest that water being used by industries, homes, schools, etc., might eventually make its way into the Concord?
4. In what other ways could a topographic map (also called "topo" maps) be useful to someone investigating the health of a river and its ecosystem?

For Teachers and Students: You can investigate other topo maps, including ones that cover your town or city, by going to the website: www.mass.gov/mgis/ftpquad.htm. This is the Massachusetts GIS website, which is a wonderful resource full of interesting and informative maps. To find your community's maps, follow the steps below:

- Once on the website, scroll down to the heading, Scanned USGS Topographic Map Images Reference. This is the Index of topo maps for Massachusetts.
- Clicking on this heading brings you to a map of Massachusetts, divided into topo squares. The light gray divisions represent the old paper USGS topo maps. The green squares are the new on-line divisions; each covers a smaller area than the old paper maps. Use the Zoom-in function to find your community. Note the six-digit numbers in the green squares that correspond with your community's map squares. For example, the four maps which correspond to the Concord River in Lowell are 217926, 217930, 221926, and 221930.
- Once you have your numbers, go back to the website and scroll down to "Go to Download Areas". Click on the link **TIFF.**
- This will bring you to a page with all of the six-digit numbers for the state. You can then select/download/save the ones you want. Have fun exploring!

3. I Got the Blues: Citizens Respond to an Environmental Problem

This activity is intended to encourage students to think about how they would respond to the presence of toxic contamination in a residential area. By doing this activity, students should be able to:

- define what toxic contamination is
- identify different points of view on an environmental issue
- distinguish between an *opinion* and an *assertion based upon factual evidence*

- understand the importance of the accurate gathering of factual evidence in determining solutions to problems

Have students read the accompanying articles: Reading One, "*Lowell Residents Beset by Chemicals in Soil, State Fences Off Yards,*" and Reading Two, "*More Toxic Sites Found, Say Activists in Lowell.*" Have them answer the questions that follow the articles. You may want to divide the class into several groups to discuss the problem.

Reading One:

"Lowell Residents Beset by Chemicals in Soil – State Fences Off Yards"
Andrew J. Dabilis *Boston Globe* - December 18, 1987

State environmental officials yesterday erected a chain link fence around the back yards of homes built over an old dump after increased traces of cyanide were found in the soil. Meanwhile, rattled residents of the neighborhood asked the state to relocate them.

Denise Hansford, who bought one of the four new duplexes built on Billerica Street along the Concord River eight years ago, said she is worried about the health of her two children and said the state should buy the residents' homes and find them a place to live in the meantime. "I was trying to sell my house just before this happened, " she said sadly in the kitchen of her two-bedroom home, where nervous residents had gathered as state Department of Environmental Quality Engineering workers worked to put up the fence. Dagma Martin, who owns one of the new homes and rents it out, said the properties could not be rented or sold. "Right now, they are not worth a penny," she said.

The fence was a precautionary measure, DEQE spokesman Myles Brown said, until further soil analyses could be completed. He said tests over the last month showed the land contained cyanide and more chemicals they believe came from the covered-over dump. The previous owner of the land, who has died, operated a dump for half a century, taking wastes from area businesses and hospitals, said Jan Schlichtmann, a lawyer hired by the residents. He said Colonial Gas Co. dumped unknown quantities of coal gasification byproducts that contained high levels of cyanide and phenol, a deadly chemical.

Brown, though, said, "We don't have anything that shows an imminent health threat or shows they would have to move." Some of the people who live in the area of the modest homes in South Lowell, where small, old homes surround the new duplexes, disagreed. "We were told everything was clean when we bought," said Lillian Klosowki, an elderly widow who lives in one of the new homes with sons. "It was a dump. Now we have cyanide, we have phenol, barium, cadmium," she added.

Problems with the land surfaced earlier this year but DEQE officials three days ago ordered stepped up tests because cyanide concentrations had turned some parts of the land blue, including spots under the children's swing sets. Hansford said when she bought "I wasn't aware it was a dump. The Realtor said it was a small problem ... being stuck on top of it is another matter."

Schlichtmann said, "The place in not a place for people to live. It's unhealthy and unsafe." He said "We are urging DEQE to cooperate with the families to work out a relocation plan so they can end their exposure. The homes are absolutely worthless and unsafe." While he said, "Our immediate concern is the health problem," he added, "We want to make the people responsible for this hazardous waste dump to pay for this."

Colonial Gas vice president-general manager John Harrington said, "We have found nothing that connects us with that." He said the company has undertaken its own investigation and was cooperating with the DEQE. Dumping of coal gasification byproducts ended in the 1940's he said.

Noreen Brodeur of the Greater-Lowell Environmental Campaign said, "We say, get these people out. They have no place to go." She said the developers of the property are out of business or can't be found.

Questions:

1. Who are the parties involved in this situation?
2. What do you think are the points of view of each of the parties involved?
3. What questions should be asked and what should be investigated before any action is taken?

Reading Two:

"More Toxic Sites Found, Say Activists in Lowell"
Andrew J. Dabilis *Boston Globe* - September 17, 1988

Standing outside a chain-link fence barricading eight homes on Billerica Street that were built on a toxic waste dump, leaders of an environmental group yesterday said a half-dozen other locations in the city have been similarly contaminated by the same company. Jan Richard Schlichtmann, a lawyer hired by Greater Lowell Environmental Campaign, blamed Colonial Gas Co. for what he said was a century-long pattern of disposing of the dangerous byproducts of coal-gas processes. "They treated the city of Lowell as their own private sewer and …toxic waste dump," Schlichtmann said. He said he has established that the company arranged for the waste to be dumped in wetlands and fields around Lowell.

Colonial Gas said later that Schlichtmann's contention that the additional sites are newly discovered is inaccurate, that each of them had "previously been brought to the attention of the public" and the Massachusetts Department of Environmental Quality Engineering. In addition, company spokesman Jack Rourke said in a prepared statement that "each of the sites is part of DEQE's cleanup program under the Massachusetts Superfund law."

The state agency last winter moved eight families out of their homes on Billerica Street after tests showed compounds dumped there before the homes were built in the late '70's including cyanide and phenols, had turned the soil blue. The families are living in condominiums in nearby Tewksbury, at state expense, while officials try to determine who is responsible for doing remedial work at the site.

Now, said Norine Brodeur, a leader of the environmental group, there is evidence of the same sort of contamination at other sites housing about 40 families. "We don't want to look at testing for the next 10 years. We want a solution," she said. The group identified the other neighborhoods contaminated by dumping as being along Monarch, Martin, Steadman, Dutton, and Riverby streets and Broadway—streets that are distant from each other.

Brodeur said gas company officials have long known about the history of dumping the coal-gas byproducts, much of which was done more than 40 years ago. She said the company has consistently denied any wrongdoing and will not accept responsibility. The group called for an immediate cleanup of all areas where toxic wastes are found, and for a new authority or commission to oversee the procedure.

A lawyer representing Colonial Gas responded that the firm has never denied it might bear some responsibility for coal-gas waste deposits scattered around Lowell. He said it has insisted only that it has few records that would clearly link its actions to the dumping. At the same time, said Ralph Child of the Boston law firm of Palmer and Dodge, "Colonial has received notices of potential responsibility from DEQE, and has agreed to take responsive action at all these sites."

However, this is likely to take some time. Child said no action can begin until state-funded tests now under way are finished next month, and their results are reviewed by both the state agency and Colonial's environmental consultants. Child said the DEQE's final site-cleanup orders also will be subject to regulatory and legal appeals.

Schlichtmann said delays could be critical because "the waste is extremely dangerous and poses a serious health threat." Schlichtmann said he used public records to find out how the gas company had disposed of wastes from 1849 to 1951, though the company had a different name during that period.

Anne Welcome, who lives near the Monarch Street area the group said is contaminated, said she remembers how 10 truckloads of wastes were dumped in a wetlands there in 1944, when she was 16. "As soon as it hit the water, there was a mist that engulfed the neighborhood. You couldn't even go out," she said. She said her husband and at least three other area residents, including a child, have died of cancer in recent years. "I've been trying to draw attention to this for 20 years," she said. In 1944, she said, more than 200 residents signed a petition and went to the board of health to force an end to the dumping.

Tim Keely, who lived in one of the off-limits Billerica Street homes, said he blamed the gas company. "Their involvement is implicit, whether it was 50 or 100 years ago. It was their waste being dumped." Denise Hansford, another resident of the area where the wastes were first found, agreed. "It's immoral for them to ruin our lives," she said.

And Lillian Klosowski, a widow who also left a Billerica Street home behind, said families are still paying mortgages of $1,000 a month or more on what she said was now a worthless property. "This is my life savings here," she said, peering through the chain link fence at the home she can't live in. "I cry every time I go by here. It's really sad."

Questions:

1. How has the situation changed in the nine months since the first article?

2. What decisions have been made?

3. Have any of the points of view of the different parties changed?
4. What questions should be asked and what should be investigated now?
5. Brainstorm with your class about possible solutions to this problem.

4. Two Views of the Same River

Below are passages that record two observers' very different responses to seeing the Concord River. Have students read each passage, and answer the questions at the end of each passage, either on their own or in small groups. The "Compare" question can be either assigned as homework or discussed by the class. For each passage, the bold print words are terms that students may not be familiar with. These terms are defined after each passage.

Passage One:

In 1839, Henry David Thoreau and his brother spent two weeks exploring the Concord and Merrimack Rivers, traveling from their home in Concord, Massachusetts, upstream as far as the White Mountains of New Hampshire. Here is an excerpt from the book that Thoreau wrote about that experience.

> "**Salmon, Shad, and Alewives** were formerly abundant here, and taken in **weirs** by the Indians, who taught this method to the whites, by whom they were used as food and as manure, until the dam, and afterward the canal at Billerica, and the factories at Lowell, put an end to their migrations hitherward; though it is thought that a few more enterprising shad may still occasionally be seen in this part of the river. It is said, to account for the destruction of the fishery, that those who at that time represented the interests of the fishermen and the fishes, remembering between what dates they were accustomed to take the grown shad, stipulated that the dams should be left open for that season only, and the **fry**, which go down a month later, were consequently stopped and destroyed **by myriads**. Others say that the fish-ways were not properly constructed. Perchance, after a few thousands of years, if the fishes will be patient, and pass their summers elsewhere meanwhile, Nature will have leveled the Billerica dam, and the Lowell factories, and the **Grass-ground River** run clear again, to be explored by new migratory shoals, even as far as the Hopkinton pond and Westborough swamp.

From *A Week on the Concord and Merrimack Rivers*, by Henry David Thoreau, 1849

Terms:

- **salmon, shad, alewives –** three species of anadromous, or migratory, fish that were native to the Concord and Merrimack Rivers and became extinct in those rivers when dams were built and pollution degraded water quality
- **weir –** a trap for fish, made of logs; water can pass through it but fish cannot
- **fry –** a young salmon
- **by myriads –** in vast numbers
- **The Grassground River –** A Native American name for the Concord River

Questions:

1. What effect have the dams and industries along the river had on the fish that inhabit it? How does the author feel about these effects? What is his hope for the distant future?
2. Why is the author not sure about who is to blame for the decline of the fish in the river? Describe what the author could do to help determine the real reason.
3. The author hopes that the fish would be "patient" and willing to "pass their summers elsewhere meanwhile." Would it really be possible for the fish to disappear, and then return many years later on their own? Why or why not?

Passage Two:

In 1869, J. W. Meader wrote a very detailed book about the Merrimack River. Included among the many descriptions of the tributaries and uses of the river is a chapter concerning the Concord River. Below is an excerpt from that chapter.

> [A] **torpid** character … is maintained by the Concord, with the exception of the falls at Billerica, [where it] throws off the **lethargy** that has held it so long in chains, and, dashing over nearly two miles of **picturesque** and powerful falls, seems to seek, and with entire success, to compensate for its former **vagrant** life, and finally throws itself with **alacrity** into the Merrimack, leaving no space between the termination of its **beneficent** labors and its final doom.
>
> It has been a marvel of idleness and stupidity for the first fifty miles of its career, … ruin[ing] much of the adjacent soil by the creation of swamps, marshes, and lagoons. It makes an earnest effort to compensate, as far as possible, by its great activity throughout the remainder of its course of about two miles, to the Merrimack. From the point indicated it is little else than a constant succession of rapids and falls, which are generally improved by men of **sagacity**, enterprise, and activity, and made to contribute largely to the wealth, industry, importance, and growth of the young and flourishing city of Lowell. The deep tinge of romance surrounding this stream in its native condition has not faded or diminished, but is, rather, intensified by the peculiarities of the men and the circumstances connected with the **inauguration** and **prosecution** of improvements around its splendid waterfalls.

From *The Merrimack River: Its Source and Its Tributaries,* by J.W. Meader, 1869.

Terms:

- **torpid –** inactive, sluggish
- **lethargy –** drowsiness, sleepiness
- **picturesque –** having a pleasant appearance
- **vagrant** - wandering
- **alacrity –** liveliness, briskness
- **beneficent –** doing good
- **sagacity –** wisdom
- **inauguration –** the beginning of something
- **prosecution –** the completion of something, the finishing of a task

Questions:

1. How does the author describe the Concord River during most of its length? Does he view it favorably?
2. What are some of the words that the author uses to describe the Concord River once it reaches Lowell?
3. What does the author view as the primary purpose of the Concord River?

Compare:

Each of these two people is writing about the same river, yet they each have very different reactions to what they have seen. Using your answers to the questions above, write a paragraph that outlines each viewer's reaction to the river, compares the two attitudes, and expresses your ideas about why the two people feel so differently.

5. What Happened to the Fish?

Below are pictures of the fish that are found on the cards used in "What Happened to the Fish?", one of the on-site activities during your visit. In the pictures, the fish are not depicted life-sized. Assign your students the task of researching the fish and preparing a presentation about the species. Their research should include, but not be limited to, the following:

- physical and behavioral characteristics of the fish (including an accurate life-size drawing)
- its habitat
- its life cycle
- its place in the food web (what it eats and what eats it)
- the degree to which it is threatened by human activity

For this last item, students might want to use the questions below to guide them as they begin their research.

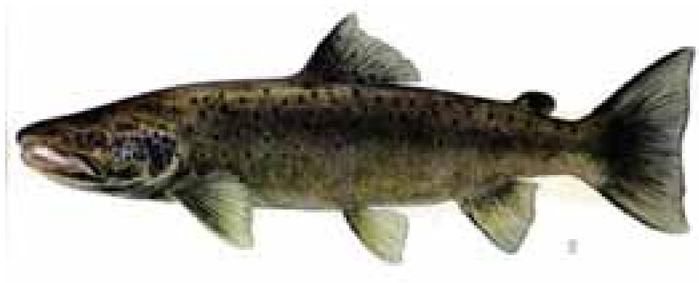
1. Which of these fish are threatened or endangered?
2. What is being done to help them?
3. Which organizations and agencies work to restore them?
4. What regulations exist regarding how they may be fished?

Use online newspapers, encyclopedias, and government or university websites. Some suggested websites include:

http://www.mass.gov/dfwele/dmf/publications/river_herring_viewing_guide.pdf
http://www.mass.gov/dfwele/dmf/publications/herring_id.pdf
http://www.fws.gov/northeast/endangered/
http://www.nytimes.com/pages/science/index.html
http://www.naturalhistorymag.com/

(For the website directly above, try the search terms "salmon" or "eel" in their search engine.**)**

Common Migratory Fish in New England



Atlantic Salmon - *salmo salar*

American Shad - *alosa sapidissima*

Eel - *Anguilla rostrata*

Blueback Herring - *alosa aestivalis*

Smelt - *osmerus mordax*

6. What Can We Do?

Often when we learn about issues that affect rivers and watersheds, the work involved to make improvements can seem immense. Are there simple, straightforward steps we can take to make change for the better?

Almost every city and town has a water department, a conservation commission, and some type of local or regional conservation group or land trust. These organizations can provide information and spur interest in students making a change at the local level. Many of them actively encourage citizen participation and youth involvement. The list below can help your students get started.

- Have students read the water quality report sent out by their Town Water Department (to every homeowner). This will familiarize them with the "language" of water protection.
- Go on-line to find local conservation organizations. Contact these organizations to find out what they as individuals, or as a class, can do to participate in water protection. These organizations can provide information and spur interest in student action.
- Have students attend a streamwalk, ponding activity, or monthly meeting of a local conservation group or land trust.
- Students interested in "citizen science" can easily order some basic monitoring equipment on their own. For about $20, they can order a basic water testing kit from www.worldwatermonitoringday.org.

Appendix: Explanation of Common Water Measurements

This information document is from the United States Geologic Survey. It can be found at: http://ga.water.usgs.gov/edu/characteristics.html

The U.S. Geological Survey has been measuring water for decades. Millions of measurements and analyses have been made. Some measurements are taken almost every time water is sampled and investigated, no matter where in the U.S. the water is being studied. Even these simple measurements can sometimes reveal something important about the water and the environment around it.

The results of a single measurement of a water's properties are actually less important than looking at how the properties vary over time. For example, if you take the pH of the creek behind your school and find that it is 5.5, you might say "Wow, this water is acidic!" But, a pH of 5.5 might be "normal" for that creek. It is similar to how my normal body temperature (when I'm not sick) is about 97.5 degrees, but my third-grader's normal temperature is "really normal" -- right on the 98.6 mark. As with our temperatures, if the pH of your creek begins to change, then you might suspect that something is going on somewhere that is affecting the water, and possibly, the water quality. So, often, the ***changes*** in water measurements are more important than the actual measured values.

Water temperature

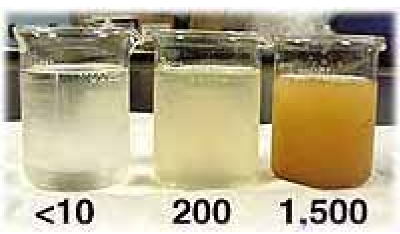
Water temperature is not only important to swimmers and fishermen, but also to industries and even fish and algae. A lot of water is used for cooling purposes in power plants that generate electricity. They need cool water to start with, and they generally release warmer water back to the environment. The temperature of the released water can affect downstream habitats. Temperature also can affect the ability of water to hold oxygen as well as the ability of organisms to resist certain pollutants. The warmer the water, the less oxygen it can hold.

pH

pH is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being neutral. A pH reading of less than 7 indicates acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic. Since pH can be affected by chemicals in the water, pH is an important indicator of water that is changing chemically. pH is reported in "logarithmic units," like the Richter scale, which measures earthquakes. Each number represents a 10-fold change in the acidity/basicness of the water. Water with a pH of 5 is ten times more acidic than water having a pH of six.

Pollution can change a water's pH, which in turn can harm animals and plants living in the water. Air pollution, in the form of acid rain, is a common culprit for lowering pH levels in bodies of water to dangerous levels. Below pH 6, eggs of fish and amphibians have trouble thriving. Below pH 5, all life in the water is in danger.

Turbidity



Turbidity is the amount of particulate matter that is suspended in water. Turbidity measures the scattering effect that suspended solids have on light: the higher the intensity of scattered light, the higher the turbidity. Material that causes water to be turbid include:

- clay
- silt
- finely divided organic and inorganic matter
- soluble colored organic compounds
- plankton
- microscopic organisms

Turbidity makes the water cloudy or opaque. The picture to the left shows highly turbid water from a tributary (where construction was probably taking place) flowing into the less turbid water of the Chattahoochee River in Georgia. Turbidity is measured by shining a light through the water and is reported in nephelometric turbidity units (NTU). During periods of low flow (base flow), many rivers are a clear green color, and turbidities are low, usually less than 10 NTU. During a rainstorm, particles from the surrounding land are washed into the river making the water a muddy brown color, indicating water that has higher turbidity values. Also, during high flows, water velocities are faster and water volumes are higher, which can more easily stir up and suspend material from the stream bed, causing higher turbidities.

Turbidity can be measured in the laboratory and also on-site in the river. A handheld turbidity meter (left-side picture) measures turbidity of a water sample. The meter is calibrated using standard samples from the meter manufacturer. The picture with the three glass vials shows turbidity standards of 5, 50, and 500 NTUs. Once the meter is calibrated to correctly read these standards, the turbidity of a water sample can be taken.

State-of-the-art turbidity meters (left-side picture) are beginning to be installed in rivers to provide an instantaneous turbidity reading. The right-side picture shows a close-up of the meter. The large tube is the turbidity sensor; it reads turbidity in the river by shining a light into the water and reading how much light is reflected back to the sensor. The smaller tube contains a conductivity sensor to measure electrical conductance of the water, which is strongly influenced by dissolved solids (the two holes) and a temperature gauge (the metal rod).

Turbidity can also be increased by the action of bottom-feeding fish, such as the alien species of carp which can be found in the Merrimack River Watershed (including Lowell's canal system).

Dissolved oxygen

You can't tell by looking at water that there is oxygen in it (unless you remember that chemical makeup of a water molecule is hydrogen and oxygen). But, if you look at a closed bottle of a soft drink, you don't see the carbon dioxide dissolved in that - until you shake it up and open the top. The oxygen dissolved in lakes, rivers, and oceans is crucial for the organisms and creatures living in it. As the amount of dissolved oxygen drops below normal levels in water bodies, the water quality is harmed and creatures begin to die off. Indeed, a water body can "die," a process called eutrophication.

Although water molecules contain an oxygen atom, this oxygen is not what is needed by aquatic organisms living in our natural waters. A small amount of oxygen, up to about ten molecules of oxygen per million of water, is actually dissolved in water. This dissolved oxygen is breathed by fish and zooplankton and is needed by them to survive.

Rapidly moving water, such as in a mountain stream or large river, tends to contain a lot of dissolved oxygen, while stagnant water contains little. Bacteria in water can consume oxygen as organic matter decays. Thus, excess organic material in our lakes and rivers can cause an oxygen-deficient situation to occur. Aquatic life can have a hard time in stagnant water that has a lot of rotting, organic material in it, especially in summer, when dissolved-oxygen levels are at a seasonal low.

Suspended sediment

Suspended sediment is the amount of soil moving along in a stream. It is highly dependent on the speed of the water flow, as fast-flowing water can pick up and suspend more soil than calm water. During storms, soil is washed from the stream banks into the stream. The amount that washes into a stream depends on the type of land in the river's watershed and the vegetation surrounding the river.

If land is disturbed along a stream and protection measures are not taken, then excess sediment can harm the water quality of a stream. You've probably seen those short, plastic fences that builders put up on the edges of the property they are developing. These silt fences are supposed to trap sediment during a rainstorm and keep it from washing into a stream, as excess sediment can harm the creeks, rivers, lakes, and reservoirs.

Sediment coming into a reservoir is always a concern; once it enters it cannot get out - most of it will settle to the bottom. Reservoirs can "silt in" if too much sediment enters them. The volume of the reservoir is reduced, resulting in less area for boating, fishing, and recreation, as well as reducing the power-generation capability of the power plant in the dam.

Do you want to test your local water quality?

Water test kits are available from World Water Monitoring Day (WWMD). Teachers and water-science enthusiasts: Do you want to be able to perform basic water-quality tests on local waters? WWMD offers inexpensive test kits so you can perform your own tests for temperature, pH, turbidity, and dissolved oxygen.

World Water Monitoring Day is an international education and outreach program that builds public awareness and involvement in protecting water resources around the world.

Information on this page is from *A Primer on Water Quality, by Swanson, H.A., and Baldwin, H.L., U.S. Geological Survey, 1965.*

Glossary of Terms

aquifer - A porous and permeable geologic underground layer that stores, transmits, and yields useful amounts of water to springs and wells.

aquitard - An underground layer of relatively impermeable material that blocks or slows the flow of water.

area of influence - The area around a well where the water table is lowered by the pumping of the well.

bedrock - Any solid rock exposed at the surface of the earth or overlain by unconsolidated material (soil). Bedrock itself is impermeable, but may contain fractures, which allow storage of water.

Clean Water Act - An act of Congress passed in 1972 to establish guidelines for the protection of our nation's water.

cone of depression - The area around a well where groundwater levels and pressure are lowered as a result of water extraction. In these low-pressure areas, the water table forms the shape of an inverted cone around the well (see also area of influence).

confined aquifer - An aquifer overlain by silts or clays that have low permeability.

contour line - A line on a topographic map that connects points on the land that are of equal elevation.

discharge area - An area where groundwater flows out of the ground into streams, rivers, wetlands, and other surface waters. Groundwater discharge occurs where the water table intersects the ground surface.

ecosystem – the interdependence of a given set of life forms and their physical surroundings

food web - a set of interconnected food chains by which energy and materials circulate within an ecosystem

fractures - Breaks or cracks in rock or soil. Fractures in Bedrock may hold water, acting as aquifers.

groundwater - Water that fills the unblocked pores or fractures of underlying material below the water table.

hydraulic conductivity - The rate at which water can pass through a material. Hydraulic conductivity is a function of permeability, viscosity, and density.

hydraulic gradient - The ratio of vertical drop of the water table to the horizontal distance of the groundwater flow.

impermeable - A soil material that will not allow water or air to pass through it.

infiltration - A process by which water passes through soil pores or bedrock fractures.

injection well - A well used for disposing of wastes deep into the ground.

permeability - The ability of a material to transmit water.

plume - A volume of groundwater containing contaminants. Usually has an elongated shape.

porosity - The ratio of air space to the total volume of a soil or rock.

recharge area - The watershed area that contributes water to an aquifer or well.

Safe Drinking Water Act - An act of Congress passed in 1974 to regulate and manage the quality of drinking water supplies in the U.S.

septic system - An on-site system for treating and disposing of wastewater into the soil.

stewardship – the act of taking responsibility to maintain and protect a clean and healthy environment

topographic map - A map showing the elevation of the landscape by means of contour lines.

water table - The upper limit of the part of the soil or underlying material that is wholly saturated with water.

water table contour line - A line which connects points of equal elevation of the water table level.

watershed - A land area within which water, sediments, and dissolved materials drain into a common outlet such as a stream, lake, estuary, or ocean.

wellhead protection area - An area around the recharge area of a well in which activities that may threaten groundwater quality are monitored and/or restricted.

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Lowell Parks and Conservation Trust: www.lowelllandtrust.org

National Park Service *Rivers, Trails and Conservation Assistance Program* online *toolbox*: http://www.nps.gov/nero/rtcatoolbox/

Sudbury Valley Trustees: www.sudburyvalleytrustees.org

United States Geological Survey (USGS): www.usgs.gov

Massachusetts Department of Fisheries and Wildlife:

http://www.mass.gov/dfwele/dmf/publications/river_herring_viewing_guide.pdf

http://www.mass.gov/dfwele/dmf/publications/herring_id.pdf

http://www.mass.gov/dfwele/dmf/publications/fore_river_feasibility.pdf

U.S. Fish and Wildlife Service:

http://training.fws.gov/library/pubs5/web_link/text/int_fish.htm

New Hampshire Fisheries: Volunteers Needed to Help Stock Salmon Fry
The N.H. Fisheries Division needs volunteers each spring to help with fish stocking and other activities; call 603-271-2501. For example, volunteers assist with stocking salmon fry in early

April as part of Atlantic salmon restoration efforts. The call for these hardy volunteers usually goes out in March:

- In central New Hampshire, the call goes out each spring for Fish and Game volunteers to help stock nearly a million small Atlantic salmon -- known as "fry" -- into several rivers and streams in the Merrimack River watershed. Volunteers must sign up in advance. Call Vikki Leonard at Fish and Game headquarters in Concord at (603) 271-2501 or email fisheries@wildlife.nh.gov.