Reading the River, Summer 2006

Why Elijah Creek Won’t Freeze

High School Biology, 9-12

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Context of Curriculum Product

After a brief introduction to scientific procedure and the characteristic of living things this unit of study will replace the "typical" unit of study on ecology. The lessons taught throughout the year are based on the hierarchy of organizations of living things, with biosphere being the highest level and molecules being the lowest level.

My intention is to incorporate additional units of study based on aquatic organisms using this hierarchy. Lessons will range from the dissection of aquatic multicellular organisms and the identification of unicellular plankton to the study of molecular structures in organisms that will include lessons on DNA extractions from algae.

I am of the opinion that the curriculum has become stale for many students and that they feel that much of the Core Content/Program of Studies for High School Science is a repeat of what was studied in middle school. My goal is to not only "cover" the required material but to try to make it fresh and get students involved in the learning process again by incorporation the local biota and environment.

Why Elijah Creek Won't Freeze

Grade Level: 9-12

Objectives

In this lesson, students will:

- Identify the main factors that shape aquatic ecosystems.
- Evaluate how biotic and abiotic factors influence an aquatic ecosystem.
- Discover how aquatic habitats can be assessed and monitored.
- Address the effects that humans have on the surrounding environment.

Program of Studies

Structure and Transformation of Matter

- Use evidence/data from chemical reaction to predict the effects of changes in variables.
- Create and/or interpret graphs and equations to depict and analyze patterns of change.

Unity and Diversity

- Compare internal, external, and metabolic characteristics of organisms in order to classify them into groups using taxonomic nomenclature to describe and justify these classifications.
- Identify and investigate areas of current research and innovation in biological science. Make inferences and predictions of the effects of this research on society and/or the environment and support these predictions with empirical data.
- Compare variation, tolerances, and adaptations (behavior and physiological) of plants and animals in different biomes.

Energy Transformations

- Investigate the flow of matter and energy between organisms and the environment and model the cyclic nature of this process.
- Explain the metabolic process of photosynthesis and describe the molecules it assembles to store solar energy.

Interdependence

- Explore ways to eradicate or lessen environmental problems caused by human interaction (e.g. examine programs for habitat restoration or wildlife protection, examine automotive/industrial emissions standards)
- Investigate changes in ecosystem and propose potential solutions to problems by documenting and communication solutions to others through multimedia presentations.

Core Content for Assessment 4.0:

SC-HS-3.4.4 Students will

- understand that plant cells contain chloroplasts, the site of photosynthesis. Plants and many other organisms (e.g., *Euglena*) use solar energy to combine molecules of carbon dioxide and water to complex, energy-rich organic compounds and release oxygen to the environment. This process of photosynthesis provides a vital link between the Sun and the energy needs of living systems.

SC-HS-3.4.7 Students will

- classify organisms into groups based on similarities;
- infer relationships based on internal and external structures and chemical processes.

SC-HS-4.6.1 Students will
- explain the relationships and connections between matter, energy, living systems, and the physical environment;
- give examples of conservation of matter and energy.

SC-HS-4.6.4 Students will
- describe the components and reservoirs involved in biochemical cycles (water, nitrogen, carbon dioxide and oxygen);
- explain the movement of matter and energy in biochemical cycles and related phenomena.

SC-HS-4.7.1 Students will
- analyze relationships and interactions among organism in ecosystems;
- predict the effects on other organisms of changes to one or more components of the ecosystem.

SC-HS-4.7.2 Students will
- evaluate proposed solutions from multiple perspectives of environmental problems caused by human interaction;
- justify positions using evidence/data.

SC-HS 4.7.5 Students will
- predict the consequences of changes in resources to a population;
- select or defend solutions to real-world problems of population control.

Materials

Lab Supplies:

1. Water monitoring equipment: LaMotte water test kits (pH, D.O.), Conductivity Meter, thermometer, and waste bottle.
2. Microscopes, slides, pipettes.
3. Coliscan Easygel test kit, incubator.
4. Preserved Specimen (Macroinvertibates)
5. Plankton net, sample bottles.
6. Dip nets, White pan, and forceps.
7. Rope for stream flow, meter stick.
8. Calculators.

Print Materials:

9. Assorted Keys and Field Guides to Aquatic Biota.
10. Posters: Stream Ecosystems, Ky Department of Fish and Wildlife Resources (and accompanying teacher's guide).
11. "Macromania; An Adventure in the Study of Stream Macroinvertebrates"
12. Assorted Topographic and watershed maps.
13. "Water Watch Water Chemistry Sampling Methods"
14. "Watershed Watch Biological Stream Assessment"
15. Watershed Habitat Assessment Protocols.
16. Kentucky Water Watch Biological Monitoring Assessment Report.
17. Habitat Assessment Field Data Sheet.
18. Watershed Watch Chain of Custody Record.
19. Assorted news releases on the water quality issues related to a local stream. (Elijah Creek, Hebron KY).

Other/ Miscellaneous

20. Mobile computer lab.
21. Digital camera.
22. Collecting permit.
23. Video: "Aquatic Biomes: Oceans, Lakes, Rivers and Wetlands"

Activity Procedure (One day = 90 minute class period)

Day 1:

- Introduction to Aquatic Biomes with an emphasis on small stream ecosystems. Students will view the video "Aquatic Biomes: Oceans, Lakes, Rivers and Wetlands."
- After the video students will list/describe/illustrate the common characteristics of all aquatic ecosystems in their science journal.
- Read and make notes on chapters one and two of "A Field Guide to Kentucky Rivers and Streams"
- In their science journal, students will list and describe the types aquatic biomes found near the school or homes.

Day 2:

- Discussion or PowerPoint on point and non-point source pollution and watersheds downloaded from Commonwealth Water Education Project http://inyourwater.org/
- Read news releases on the local stream Elijah Creek and the effects of change brought by human development, namely the dumping of ethylene glycol (antifreeze) from the Northern Kentucky International Airport as part of aircraft de-icing procedures. Discuss the impact on this aquatic ecosystem that has occurred and the current and on-going problems. Talk about the Water Watch program and the Sierra Club Water Sentinetals.

Day 3:

- Speaker (One of the following)
  Tim Guilfoile from Sierra Club Northern Kentucky Water Sentinels.
  Heather Mayfield from ORSANCO
  Marc Hult from Daniel Carter Beard Environmental Center

Day 4:

Workshop on stream monitoring using the Water watch protocol. (Biotic Factors)

- Review the booklet "Watershed Watch Biological Streams Assessment" discuss the contents.
- Use "Macromania" to introduce macroinvertebrates as water quality indicators. Use preserved samples to establish the "real size" and look of these organisms.
- Discuss plankton sampling (not part of Water Watch), but samples will be preserved and used as a later date.
- Discuss water collections and culturing for bacterial sampling.
- Review the booklet: "Watershed Habitat Assessment Protocols" using the field data sheet have student assess "pictures/video images" of streams.

Day 5:

Workshop on stream monitoring using the Waterwatch protocol. (Abiotic Factors)

- Review the booklet "Watershed Watch Water Chemical Sampling Methods"
- Practice the following chemical tests on sample water: DO. PH, conductivity and water temperature working in lab stations for each parameter.
- Discuss measuring and counting stream flow. (Practice calculations)

Day 6:

- Practice run or review of the procedures and data collection in simulated situations.

Day 7:

- Field study assessment of Elijah Creek (Location church parking lot)
- Students will be divided into teams to assess one or two parameters and record the data on the appropriate Watershed watch field data sheet.
- After returning to school student will turn in all data sheets, samples for further analysis.

Day 8:

- Review data collected during field study.
- Using the mobile computer lab students will compare data collected during the field study to that of data collected by the USGS (website). Elijah Creek is monitored creek with real time data collection.
- Students will write a brief lab report on the ecological health of this small stream ecosystem.

Day 9:

- Readings from A Sand County Almanac; The Land Ethic, The Community Concept
- Discuss what we can do to make the issue known or express feelings on the issues related to the polluting of Elijah Creek.
- Students will choose from one of the following projects assignment: (however, I am always open to other ideas that the student may come up with): Create a news release with photos, write a letter to a congressmen or representative, write/record a song, create pamphlet for public library, design/produce a poster or tee shirt on water quality issues, produce an exhibit panel for display at local library, produce a documentary short.

Day 10:

Final presentation/project will conclude approximately 2 weeks after students are given the final project assignment.

Definition/Explanation of Concepts/Skills

River, streams, creeks and brooks are all fresh water ecosystems with water that flows above ground. These ecosystems are part of a larger system: a watershed. It is all land that water drains through on its way to a stream, creek, or river. Aquatic ecosystems are classified principally by the chemistry of the water, depth, flow, and temperature. The communities that develop in and around the waters are determined by these factors. Any alterations to land or water in the watershed may impact the inter-relationship between communities in that watershed.

The abiotic factors that define a stream also define the types of organisms that can survive in that aquatic ecosystem. In turn, many of the biotic factors influence the abiotic factors. Organisms have adapted to flow rate such as some insect larvae that have hooks that allow them to grip rocks or vegetation. Another example is the streamlining of fish to help them to move against current. Turbulent water can help distribute heat, oxygen and nutrients throughout the ecosystem. The rocky substrate of most streams, provide the perfect habitat for the breeding, growth, and development of not only invertebrates such as insects and crustaceans, but for fish and amphibians. The growth of vegetation (the riparian zone) around the stream can shade the water therefore changing the temperature and the amount of oxygen created and dissolved in the stream. Riparian zones also act as filters to reduce the flow of water after storms and offer a buffer against pollutants that flow into a steam. There is a direct connection between water quality and biodiversity in an aquatic ecosystem; any chemical or physical change should prevent some species from using the habitat.

Water monitoring determines the health of a creek, stream or river. Various components of the aquatic ecosystem can be measured and compared to ideal water quality standards. Stream health is influenced by several parameters such as habitat conditions around the stream, the riparian zone around and in the stream, aquatic insect populations, and the chemistry of the water (namely pH, dissolved oxygen, and conductivity). Streams are frequently indicators of events that occur within the watershed. Healthy steams normally contain a diverse population of organisms.

There has been on-going effort with business leaders, government officials, environmental activist groups, as well as local citizens to remedy a serious issue related to the water quality of several creeks located in Boone County, Kentucky. The water quality has been severely affected by the runoff of ethylene glycol during the de-icing of planes at the Greater Cincinnati/Northern Kentucky International Airport. Although restoration efforts have begun much still needs to be done. By raising the consciousness of students to this local environmental concern they will be able to use inquiry based learning to develop a sense of discovery and critical thinking skills. If students become aware of how sensitive and important our waterways are they are more likely to develop a wise stewardship of our natural resources.

Assessment

1. Review student practice of completing the stream assessment sheet for understanding of the different parameters used in water quality monitoring.
2. The word list maintained in students' science journals during the unit will be checked for completeness.
3. Student stream assessment sheets for the field study of Elijah Creek will be evaluated for completeness and correctness.
4. Lab report on the field study of Elijah Creek will be graded (using rubric).
5. Evaluate final project using appropriate rubric.

References

A Field Guide to Kentucky Rivers and Streams. Kentucky Division of Water (revised 1986). Kentucky Natural Resources and Environmental Protection Cabinet

The Licking River Region in Kentucky: Status and Trends. Kentucky Division of Water (1998). Frankfort, KY

Lorentz, C. (2005) *Aquatic Ecology for Teacher Course Handbook.* Unpublished stream assessment data sheet. Thomas More College

Water Watch Water Chemistry Sampling Methods; For Field Chemistry and Analysis. Kentucky Division of Water (2000). Kentucky Natural Resources and Environmental Protection Cabinet

Watershed Watch Biological Stream Assessment. Kentucky Division of Water (revised 1986). Kentucky Natural Resources and Environmental Protection Cabinet

Watershed Habitat Assessment Protocols. Kentucky Division of Water (1999). Kentucky Natural Resources and Environmental Protection Cabinet

Accompanying materials

Many of the materials both print and multimedia that were used for this unit of study can be downloaded from the following website. Some files are quite large and slow to download without a high speed internet connection. The handbooks for the Water Watch Protocol of stream assessment (Chemical, Biological and Habitat) as well as the data collection sheets.

http://kywater.org/watch/workshops/

Accompanying materials

Document can be downloaded in PDF from the web address below

the planet newsletter

Water Sentinels Stop Toxic Antifreeze Runoff - March/April 2005 Planet Newsletter - Sierra Club
..."I was blown away," says Northern Kentucky Water Sentinels staffer **Tim Guilfoile** after the new permit was issued on February 7. "The permit isn't perfect, but the state obviously listened to our concerns." Water Sentinels...
http://www.sierraclub.org/planet/200502/antifreeze.asp

Water Sentinels Stop Toxic Antifreeze Runoff

by Tom Valtin
Antifreeze in your car: good.
Antifreeze in the babbling brook next door: not good.
But years of de-icing fluid runoff from the Cincinnati/Northern Kentucky Airport have poisoned long stretches of Gunpowder and Elijah Creeks, both tributaries of the Ohio River. The pollution got so bad that in recent years snow along the creek banks turned black and the creeks wouldn't freeze.

Frozen Creek a Harbinger of Health: Before a water treatment facility was installed on Gunpowder Creek last year, antifreeze runoff from the Cincinnati/Northern Kentucky airport kept the creek from freezing over and turned the snow black on the creek banks. This photo, taken in January 2005, shows that the pollution controls are working.

To the rescue, the Sierra Club's Water Sentinels Program, which over the course of a three-year campaign successfully pressured the airport to agree to install more than $50 million in pollution controls, and the state of Kentucky to issue a new, stronger discharge permit.
"I was blown away," says Northern Kentucky Water Sentinels staffer Tim Guilfoile after the new permit was issued on February 7. "The permit isn't perfect, but the state obviously listened to our concerns."
Water Sentinels activists did ongoing water quality monitoring of the two creeks. Working with local residents, fly fishers, and the local watchdog group Licking River Watershed Watch, Club staff and volunteers lobbied the airport and the Kentucky Division of Water to address the problem, testifying at public hearings and keeping the issue in the media spotlight.
"This was a classic organizing effort," says Water Sentinels Director Scott Dye. "There's no doubt the Sentinels' concerted pressure on public officials is what finally forced the airport's hand."


Tim Guilfoile

The culprit is ethylene glycol, better known as antifreeze, which harms the brain, heart, lungs, and other organs. In water, it gobbles oxygen, leaving none for fish or other aquatic life.
"These creeks flow into the drinking water source for millions and millions of people," former Northern Kentucky Water Sentinel Heather Mayfield told the local ABC-TV News affiliate last May. "Citizens have been complaining for years, but the pollution problems persist and people are getting upset. They're getting sick of it!"
One person who got sick of it and spoke out was Deloris Burke, 76, who has lived alongside Gunpowder Creek for more than 50 years. Burke used to water her garden and fill her swimming pool with water from the creek, but that was long ago. At a September public hearing organized by the Sierra Club, she told state officials the chemical smell from the creek was so strong she has to keep her windows closed during the summer.
In advance of the hearing, the Water Sentinels printed flyers alerting residents of the Oakbrook subdivision, through which Gunpowder Creek flows, that the pollution jeopardized their health - particularly children, who are most apt to play in the creek. The flyer pointed out that antifreeze in the creek didn't do much for property values either.
"The hearing was packed," says Guilfoile, who replaced Mayfield last fall. "And it wasn't just environmental groups or sporting groups speaking out; it was John Q. Citizen from the Oakbrook subdivision."
"The Sierra Club was absolutely critical in making the public aware of this issue," says Ann Gunkel, an environmental engineering professor and Oakbrook resident who also testified at the September hearing. "The Club did literature drops, recruited volunteers, got people out to meetings, and did the water-quality sampling that served as the science behind the activism."
With her background in environmental science - and as a mother afraid to let her kids go anywhere near the creek - Gunkel became a community spokesperson, going door-to-door to talk with neighbors. She also had her students draft a letter to the state urging that the situation be addressed ASAP.


Heather Mayfield

The Kentucky Division of Water has monitored airport runoff for years, and in 1997 it issued a discharge permit to the airport, along with a $150,000 fine and a cleanup order stating that the two creeks were "severely impacted" by de-icing fluid in violation of state clean-water laws. Yet the airport was allowed to continue polluting with no further fines even after the permit expired in 2002. Mayfield, who still volunteers with the Sentinels, says even when the 1997 permit was in force, it allowed too much antifreeze to be discharged. "Other airports, Chicago, for instance, allowed barely one-eighth as much runoff pollution as was permitted here."
The permit was further flawed in that it moved the monitoring points, failed to spell out penalties for violations, and required the airport to monitor the streams only once a week. "We've found huge swings in water quality within 12-hour periods," Mayfield points out. "Continuous monitoring is critical." In a major victory for the Water Sentinels, the new discharge permit, issued on February 7, states that both Gunpowder and Elijah creeks will now be monitored continuously.
Throughout its campaign, the Sierra Club emphasized that it is not opposed to the use of de-icing fluid, which is necessary for planes to take off in cold weather. "Our beef was with the state, not the airport," Mayfield says.
The airport has spent $38 million to date on water-treatment facilities and a recycling system to keep de-icing fluids out of the local creeks. A new treatment plant was installed January 2004 at the headwaters of Gunpowder Creek, which rises on airport property. In September, a series of pipes was installed to collect the glycol from runway de-icing pads and funnel it to storage tanks where the water is boiled off and the glycol separated out. A second treatment plant to clean the water headed for Elijah Creek is scheduled for completion in 2006.
The facility on Gunpowder Creek was put to the test over the holidays when a huge snowstorm hit Cincinnati. The storm was so severe that the airport ran out of de-icer and had to have more trucked in.
"For the first time, we found no evidence of de-icers in Gunpowder after the storm," exults Scott Dye. "It looks like we've finally turned the corner."
"We demonstrated that the Water Sentinels can muster public support for water quality," Guilfoile says. To learn more about the Water Sentinels Program, see sierraclub.org/watersentinels.

Smokestack photo: Corbis/Royalty-Free; used with permission.
Creek photo: Tim Guilfoile; used with permission
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