Freshwater Ecosystems in Kentucky: Our Rivers, Streams, and Lakes

Length of Unit: 6-8 weeks
Grade Level: 7-8

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* This unit is an extensive look at the waterways of Kentucky: their physical, economic, historical, environmental and aesthetic qualities and impact on the state of Kentucky, extending to surrounding states and waterways. Lessons on rivers are incorporated among lessons of geology, forestry, soil studies, geography & topography, NPS & PS pollution, as well as the incorporation of a variety of mathematical and scientific skills.

The lessons that deal with rivers and water quality are annotated below, in the sequence that they would be introduced into the unit. These lessons can be used alone as a smaller unit on waterways and water quality. The unit sequence follows and the lesson marked with the asterisk is given in detail.
Italicized items: Sources for these can be found in the Resources section

#1 **Characteristics of a river/river system**: Introduce rivers unit with Jeopardy type review game for students' previous knowledge on rivers, waterways, and their watershed areas. At conclusion of game, orally review the previous knowledge of students, and ask if any have been involved in any river clean-ups, or know of any news concerning a creek near their house, or the Licking or Ohio rivers. (there may have been newsworthy items recently, or students might discuss the conditions of creeks they are familiar with in their neighborhoods.) Students pay attention to the news for a length of time, and save articles or notes on TV. shows that deal with either local or global water issues.

#**2 Rivers of Kentucky/Watershed areas in Kentucky**
Students locate major rivers on *Ky. maps*, and pick one river to work on as a small group to complete a project. Each group highlights the river on their map. Using *watershed area map*, roughly outline your rivers watershed area; highlight cities, roadways, and other obvious human presence in your watershed area. Project for each group involves researching the cities, housing developments, dams, roadways, man-made lakes, etc. that are found in their river's watershed area (use resources such as the Internet, newspapers, Ky. magazines, local chambers of commerce, local historical societies, conservation districts, and the *KGS - Kentucky Geologic Survey*). Students gather as much information as possible on positive and negative aspects of their river's watershed area and present this information to the class at a later date.
* the RiverLab Stream Table is used with this lesson after the river locations are found on the maps. This equipment uses a sand medium and flowing water to represent river formation, erosion, deposition, and the movement of groundwater. Students work with the sand to create a river channel, and surrounding watershed area with areas for human development, riparian zones, vegetative coverings, and dams. Movement of pollutants through the soils and into the water can be followed and monitored. Streamflow can also be measured using this table.
* Videos from the public library can be shown that feature the local rivers in a historical, economic, or recreational manner, to show students actual pictures of the rivers in Ky., since a fieldtrip to all these rivers is not realistic. (A fieldtrip follows in the unit)

#3 **Watershed regions of Kentucky: Scale reproduction**
Students use scale measurements to enlarge the map drawing of their river's course and watershed area- only their river is enlarged (use accurate data gathered in previous research).

Cities, towns, other human interactions, and natural features are included n the enlarged map. This map becomes part of their group presentation.

* Local speakers, either officials or citizens can be invited who either work on the river, or have a business or a farm in the watershed area and practice water conservation. Local Conservation Districts and Extension Services are good resources to find speakers.

#4 **What makes a healthy waterway? Biotic and Abiotic factors:**
Components of water quality and habitat assessment are explained. (*Water Watch handouts*) Posters, pictures, video clips, students' previous experiences, and the classroom steam aquarium are used to help explain concepts to students. Chemical testing techniques are explained, using the directions that come with the testing kits. (Copies of the directions for all of the chemical tests should be provided for each student). Methods and techniques for conducting the habitat assessment are explained. *Identification guides for micro and macro invertebrate* identification are given out and reviewed. Proper use of a microscope is reviewed as necessary. Macroinvertebrate studies will be conducted on the digital microscope and are viewed on the computer screen where samples can be recorded, measured, and saved for future use.

#5 **Micro and macro invertebrate identification** (practice)
Review students' previous knowledge about aquatic micro and macro invertebrates- their habitats and life cycles; aquatic food webs. Give student groups identification sheets, guides and a key. Students use samples from the classroom aquarium and practice using the microscopes and identification guides to identify the organisms. Samples of invertebrates from local streams can be brought in to add to the variety of organisms to identify. Student groups record written and drawn information on what their sample contains.

#6 **Testing for water quality/ Practice for chemical testing and habitat assessment**
** Lesson plan included

#7 **Follow up fieldtrip to a local stream** where water quality testing and assessments can be done for the local stream.

#8 **Fieldtrip to Thomas More Field Biology Station** to conduct more extensive investigations on macro and micro invertebrates, riparian zone vegetation and conditions, water filtration, fish identification, and wetland environments.

#9 **More in-depth study of students' local watershed area**; Community walk to assess potential problem areas, land use, and where runoff goes. Data recorded to make a local map (could be a 2 square block area of the community, just the school grounds, or a particular neighborhood-whatever is a realistic area to investigate)

#10 **Fieldtrip to mouth of Licking River at the Ohio River in Covington**. Students assess the habitat and water quality at this site. Students make observations and record data for man-made influences in the watershed area here. There are two watershed areas to consider- the Ohio and the Licking Rivers. Do they influence each other?

#11 **Small groups prepare a brochure to highlight the *local* watershed area and its characteristics**- both positive and negative- that influence the health of our local waterways (streams, Licking and Ohio rivers). A class campaign to bring awareness to the community for its responsibility to a healthy watershed area is started. Simple things that citizens can do, such as disposing of cigarettes properly and not in the street to be washed down the storm sewers, or not dumping used oil in your grass or driveway, can be areas for which student groups design and implement an Action Plan for Awareness. Student groups implement their action plans either schoolwide or for the community/parish

#6 Testing for water quality; Chemical testing & Habitat assessment
Lesson: Testing for Water Quality / Using tools and equipment
Length: 90 minutes, or 2- 45 minute periods
Grade Level: 7-8

Objectives:
Students will be able to:
* accurately use measuring tools and equipment to monitor criteria of water quality.
* assess a stream aquarium's overall health by using standard testing techniques such as pH. testing, dissolved oxygen, habitat assessment, temperature, nitrate and nitrite testing, and ammonia levels.
* record and explain data recorded during testing activities and use this data in an analysis of our classroom stream aquarium's water quality.

Program of Studies:

Scientific Inquiry: Students understand scientific ways of thinking and working and use those methods to solve real-life problems. The following are for 7th and 8th grade levels:
S-7/8-SI-1: Students will identify and refine questions that can be answered through scientific investigations combined with scientific information.
S-7/8-SI-2: Students will use appropriate equipment, tools, techniques, technology and mathematics in scientific investigations.
S-7/8-SI-4: Students will design and conduct different kinds of scientific investigations to answer different kinds of questions.
S-7/8-SI-5 Students will communicate designs, procedures, and results of scientific investigations.
S-7/8-SI-6: Students will review and analyze scientific investigations and explanations of other students.

Conceptual Understanding:
S-7-ESS-4: Students will examine evidence for changes in environmental conditions and life.
S-8-LS-4: Students will investigate and analyze populations and ecosystems.
S-8-LS-5 Students will analyze diversity and adaptations.

Applications/Connections
S-8-AC-3: Students will recognize how science is used to understand changes in populations, issues related to resources, and changes in environments.

Academic Standards:
SC-M-3.5.1 A population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.
SC-M-3.5.2 Populations of organisms can be categorized by the function they serve in an ecosystem. ...Plants are producers,...decomposers, primarily bacteria and fungi, are consumers.....

SC-M-3.5.4 The number of organisms an ecosystem can support depends on the resources available and abiotic factors..... Lack of resources and other factors limit the growth of populations in specific niches in the ecosystem.

Content Knowledge: Lesson #5

Water quality and a healthy overall habitat is essential for Kentucky rivers to remain a viable resource for economic, recreational, and aesthetic activities for the state's citizens. The rivers that run through and around Kentucky are connected to the global waterway system, and our activities and use of the rivers and lands in Kentucky can have not only a statewide influence, but also a more far-reaching effect on waterways outside of our state. What we do as citizens of Kentucky, now and in the future, will determine the conditions of our rivers and streams, and whether or not we will be able to make and maintain Kentucky's waterways as healthy habitats.

Water quality of a stream or river is determined by using the presence or absence of biotic and abiotic factors. A variety of tests are used, both visual and chemical. Many factors influence the overall health of a waterway: the pH levels (measuring the acidity or alkalinity of the water), dissolved oxygen (how much available oxygen is in the water for organisms), ammonia levels (generated by animal waste materials); fecal coliform (measures amount of fecal bacteria from animal wastes); turbidity (how clear is the water- are sediments or other organisms clouding the water?); temperature; type and amount of substrate cover; vegetation in and out of waterway; and the presence or lack of micro and macroinvertebrates, as well as vertebrate species.

Many organisms, both vertebrate and invertebrate, have particular environmental conditions that must be met in order for them to survive and reproduce. Some aquatic organisms are very tolerant of a wide range of water conditions, such as aquatic worms and midges. Other aquatic or semi-aquatic organisms are more sensitive to environmental conditions and need a higher water quality in order to survive and reproduce, such as mayflies, stoneflies, riffle beetles, mussels and the caddisfly. These are called indicator species, because their presence or absence can indicate a waterway's health and viability. The presence of less tolerant species in a waterway indicates a healthier stream than one that has only aquatic worms and midges. Chemical water testing and habitat assessments can be predictors of the current and future heath and viability of a waterway.

The waterways in Kentucky are surrounded by land. This land and all that it includes are part of the watershed areas for the rivers in Kentucky. A watershed area is the area of land that surrounds a body of water, and which drains into that body of water. There are 13 major watershed areas in Kentucky: the Licking River, Green River, Upper & Lower Cumberland River, Tygart/Little Sandy Rivers, Big Sandy, Tradewater, Tennessee River, Mississippi River, Kentucky River, and the Salt River watershed. The activities in the watershed areas, both human and natural, have a direct effect on the rivers in Kentucky. The water quality testing presents evidence of how the aquatic environment is surviving the influences of man and nature.

Essential Questions:

* How can a stream's health be assessed?
* How do biotic and abiotic factors work together to maintain a healthy stream ecosystem?
* Why is it necessary for there to be both biotic and abiotic components in a healthy stream ecosystem?

Materials for lesson:
* RiverLab Stream Aquarium (or other inside aquarium)
* Water Watch Stream Monitoring Manual (provide one copy of the sampling, testing, and assessment techniques sections, for each group of 4-5 students)
* handouts for instructions on how to measure the flow rate of a stream (two for each group)
* water testing materials and equipment for pH, dissolved oxygen, temperature, ammonia, nitrate, and nitrite tests (all or some of the tests can be done by all or some of the student groups- teacher's choice)
* copies of the directions for all chemical tests (2 copies per group)
* *Pond Life* books for each group (1 or 2 per group)
* Micro and macro invertebrate identification sheets
* equipment to measure flow of stream (tape measure, meter stick, Ping-Pong ball, watch with a secondhand)
*Goggles for each student
*Data sheets (Water Watch water quality assessment sheets; Journals for more detailed written observations of what they did and observed)

Activity:
1. Arrange for groups of 4-5 students to work together
2. Introduce the activity as a scientific inquiry into the health of the classroom stream aquarium, and as a practice session for techniques of water testing prior to a stream fieldtrip.
3. Each group should be provided with copies of the instructions for the water quality testing that is coming up (ph, dissolved oxygen, temperature, turbidity, vegetation cover, substrate, flow rate, micro and macro invertebrate populations).
4. Discuss the classroom stream aquarium before any testing is started- does it appear to be a healthy system? What are some of the abiotic and biotic factors in this particular stream environment? How is this stream different from a natural stream?
5. Assign a particular test for each group to perform on the stream aquarium: pH, dissolved oxygen, ammonia (since it is a contained stream), habitat assessment, etc.; each group should read, and within their group, discuss their particular information from the handouts. (Teacher assists groups with understanding their testing techniques)
6. After 15-20 minutes, each group should briefly (2-3 minutes) tell the whole class basic information on what their group will be doing and why it's important to assess this factor in monitoring for a healthy stream. (This discussion is only done once, to make sure students understand what they are testing for and why)
7. *Water Quality Assessment Data Sheets* are given to each student in each group. Each group begins their particular test on the stream aquarium. (goggles and gloves worn). Record all data and general observations. Groups conducting chemical tests can collect a water sample and return to work tables to complete the testing. Students measuring habitat and stream flow can gather around the aquarium. All groups record data on the data sheets provided. Testing should be completed within 30 minutes. (Teacher assists in chemical testing; assists other groups to make sure proper testing techniques are learned)
* At the end of all rotations, all group data is recorded on a large poster size class chart(s) for the results of the aquarium's water quality assessment.

9. Student groups should all be rotated so that each group performs each test- the time period for testing rotations should be cut down to 8-10 minutes as students get the hang of it.
10. After groups have completed their rounds of testing the aquarium, record all results on a large class chart, so all results can be seen; discuss the recorded results and determine an overall health rating for the stream aquarium
* What exactly is making it work like a system? (interrelationship of biotic /abiotic factors)
* What factors are controlled or influenced by us in the classroom? What can we do to improve our classroom stream habitat?

Follow-up: Discuss any problems or difficulties students may have had in obtaining accurate results; Discuss how factors can be different in a natural stream compared to a classroom stream, and talk over some differences they might see on a future real î stream fieldtrip. Using students' previous research knowledge into the watershed areas of Ky., devise a list of possible threats they might observe in a natural stream environment, and also a list of positive characteristics they would like to see in the stream environment chosen for the fieldtrip.

Assessment: Student data sheets for designated water quality tests will be reviewed to assess their skill levels. Discussions with the student groups as they are conducting their tests will be used to assess levels of students' understanding for testing techniques as well as an understanding of the abiotic and biotic factors that determine water quality in a stream. This is a practice lesson for water quality testing, so room for errors should be allowed. more in-depth assessment can be arranged for the fieldtrip when a natural stream will be tested and assessed.

Assessment considerations:
1. Did the student use correct measurement techniques and tools for assessing each criteria for water quality and habitat assessment?
2. Was there a particular concept that the student did not show an understanding of, for either the testing method used or the purpose of a test?
3. Was the student able to perform the testing techniques accurately and record data in an organized way?
4. Did the student demonstrate an understanding of the interrelationships between biotic and abiotic factors in a stream ecosystem?

Rivers Unit / Lesson Resources:
*Water quality content material, micro and macro invertebrate identification guides, habitat assessment and water quality assessment data sheets:
Water Watch publications: http://www.state.ky.us/nrepc/water/wwhomepg.htm
*Posters of a variety of water related habitats:
Ky. Department of Fish and Wildlife http://www.kdfwr.state.ky.us/teacher.htm
*Kentucky state maps: AAA (American Automobile Association, with membership); Kentucky Department of Tourism
* Reid, G. & Zim, H. (Editor). (2001) Pond life: A guide to common plants and animals of North American ponds and lakes. St. Martinis Press, Golden Guide Series.
* Water testing kits - chemical: LaMotte http://www.lamotte.com/
* KGS (Kentucky Geologic Survey): http://www.uky.edu/KGS/