

Reading the River, 2006

Ecology

10th Grade Biology

**Keri Johnson
Powell County High School**

June 2006

Core Content

SC-HS-4.7.1 Students will

- **analyze relationships and interactions among organisms in ecosystems;**
- **predict the effects on other organisms of changes to one or more components of the ecosystem.**

Organisms both cooperate and compete in ecosystems. Often changes in one component of an ecosystem will have effects on the entire system that are difficult to predict. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years. DOK 3

SC-HS-4.7.2 Students will

- **evaluate proposed solutions from multiple perspectives to environmental problems caused by human interaction;**
- **justify positions using evidence/data.**

Human beings live within the world's ecosystems. Human activities can deliberately or inadvertently alter the dynamics in ecosystems. These activities can threaten current and future global stability and, if not addressed, ecosystems can be irreversibly affected. DOK 3

SC-HS-4.7.3 Students will

- **predict the consequences of changes to any component (atmosphere, solid Earth, oceans, living things) of the Earth System;**
- **propose justifiable solutions to global problems.**

Interactions among the solid Earth, the oceans, the atmosphere, and living things have resulted in the ongoing development of a changing Earth system. DOK 3

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.**

Living organisms have the capacity to produce populations of infinite size. However, behaviors, environments, and resources influence the size of populations. Models (e.g., mathematical, physical, conceptual) can be used to make predictions about changes in the size or rate of growth of a population. DOK 3

Program of Studies:

Goals, Objectives, and Essential Questions:

Objectives:

Students will:

- Identify the hierarchy of organism organization (organism, population, community, ecosystem, biome, and biosphere)
- Understand the interrelationships and interdependences of organisms within an ecosystem
- Understand and identify human-caused problems in the environment

Essential Questions:

- How are each of the organisms within an ecosystem arranged?
- How do humans interact with the environment?
- What types of problems have humans caused within the environment?

Lesson I: This lesson will be completed at the beginning of the ecology unit. The following activity will be used to determine any prior knowledge the students have about ecosystems.

Materials:

- Jenga Blocks (each block is labeled with different components found within an ecosystem...producers, consumers, decomposers, abiotic factors)
- Marker Boards and Markers
- Extended Anticipation Guide

Procedure:

Students will complete an extended anticipation guide. The anticipation guide will serve as a reading strategy for the class. The guide will make statements about ecology; students will choose either to agree or disagree with the statements. After reading through the statements, the students are assigned certain pages in the book to read. Once the students have completed the reading assignment, they will look at the statements on last time. This time, they will determine if they were incorrect/correct to agree/disagree with the statements. They will have to use content from the reading to defend their answers.

Students will then be broken into groups of three. Each group will be given a Jenga game. Each of the individual blocks has a word written on the block. These words correspond with decomposers, producers, consumers, and abiotic factors in the environment. Before building their tower, students will group the blocks according to their own classification scale. They will record their classifications with an explanation on a Data collection sheet provided for them. Once they have made their classifications, they will build their tower. The students will be instructed to put the most integral parts of the environment at the base of the tower and work their way up. Once they build their tower, they will begin to “play” Jenga. They will realize that everything is important in maintaining the stability of the environment, and the smallest impact made by humans will affect the environment.

Once the students have completed the activity, they will remain with their groups. Each group will be given a marker board and markers. The individual groups will develop concept maps based on the terms we discussed in class as well as anything they have learned from the activity. Each group will share their concept map with the class along with an explanation for their map.

As an exit strategy, the students will answer the following questions after finishing the activity:

1. How did your group classify the Jenga blocks?
2. How did the Jenga activity relate to real world examples of ecology?
3. What was one key observation your group made while participating in the Jenga activity?
4. What real world examples can you use to identify with the activity?
5. When designing an ecosystem (like the Jenga tower you built) what kinds of organisms make up the base of the ecosystem?

Lesson II:

Our school is located within the 30-45 minutes of Gladie Creek which is located very close to the headwaters of the Red River. For this activity, students will be taken to Gladie Creek to conduct habitat assessments, water quality tests, and macroinvertebrate studies. This lesson will be conducted at the end of our ecology unit.

Materials:

- Lamotte conductivity meters
- Lamotte DO test kits
- Lamotte pH test kits
- Thermometers
- Nets
- Habitat Assessment Guides
- Macroinvertebrate Identification Key
- Homemade Underwater Viewers
- Kentucky Water Watch Biological Monitoring Assessment Report

Procedure:

Students will begin this lesson by completing the concept map (attached) in pairs on stream assessment. The concept map is already labeled with the different components of stream assessment that will be tested on our field trip. In order for the students to become familiar with *why* the tests are taken, under each component, they will write the importance and justifications for the tests in stream assessment. The concept maps will be discussed in class after each pair of students has had a chance to complete them. Before being taken to Gladie Creek, the students will read the article "Stream Ecology" (attached) to become more familiar with the various aspects of stream ecology.

Students will be taken to Gladie Creek to conduct several tests on the water quality and habitat in and around the stream. The purpose of the field trip is to allow students first hand experience at gathering data in the field. They will become accustomed to proper scientific protocol in field testing.

Upon returning from the field trip, students will be asked to move back into their field groups. As a group, the students will complete the guided question "Is Gladie Creek an example of a good stream habitat?" (attached). Students will learn to use the data they have collected while in the field to produce a conclusion. While completing the question, students will be justifying their conclusion based on the data presented. The class will discuss their conclusions with the class.

Definition/Explanation of Concept/Skills Taught in Lesson:

Students will be taken to the field in order to get real world experience. It is important for them to realize not only how, but why these individual tests are being performed.

Upon performing water chemistry, students must understand what each component has to do with stream ecology. Students usually realize that organisms need a certain temperature and pH range in order to live. It is sometimes hard for students to understand that fish and other aquatic organisms have to get their oxygen from the water in the form of dissolved oxygen. Students need to realize that oxygen is not distributed evenly within water as it is in the air. They also need to understand that different factors such as salinity, pH, and temperature will affect the DO concentration and distribution. Another component students have a hard time with is conductivity. Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). A failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate; an oil spill would lower the conductivity. The conductivity of rivers in the United States generally ranges from 50 to 1500 $\mu\text{mhos/cm}$. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 $\mu\text{hos/cm}$. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates. Industrial waters can range as high as 10,000 $\mu\text{mhos/cm}$.

Habitat assessments and macroinvertebrate studies are conducted to evaluate the area surrounding the stream and what types of organisms are present within the stream. Certain types of macroinvertebrates are more tolerant than others. Using that guide, if you find more intolerant species, the stream is less polluted, more tolerant species indicate the stream is being subjected to pollutants.

Method to Assess Stated Objectives:

Most assessments made during this unit will be done informally throughout the unit. The informal assessments will be based on discussions in class and the concept maps created, as well as other in class assignments. Formal assessment will be completed at the culmination of the unit with the completed field work and the unit test.

References:

Izaak Walton League of America. (1994). Stream Insects and Crustaceans. *The Save Our Streams Teacher's Manual*.

Ohio State University Extension. (1998). Streams: The Rivers in Your Backyard. *Master Watershed Stewards*. 41-62.

U.S. Environmental Protection Agency. (n.d.). *Monitoring and Assessing Water Quality*. Retrieved July 26, 2006 from <http://www.epa.gov/owow/monitoring>.

Stream Ecology

No ecosystem can be studied in isolation. If we were to describe ourselves, our histories, and what made us the way we are, we could not leave the world around us out of our description! So it is with rivers: they are directly tied in with the world around them. They take their chemistry from the rocks and dirt beneath them as well as for a great distance around them.

The Watershed

The area that a stream drains is called its **drainage basin**, or **catchment area**. We also often call it the river's **watershed**. Water flows downhill (unless it evaporates, freezes, or is taken up by plants). So when it falls as rain, melts from snow or ice, or bubbles up from beneath the earth, it will either flow one direction or another, and always downhill. If you were to stand by a stream at the bottom of a valley, you might look up and see hills all around you. All the land you see that slopes downward toward your river is part of the river's drainage basin. Some drainage basins are so unbelievably huge that you can't even see where their downhill flows begin. For instance, if you stood by the Mississippi River, you couldn't see the Rocky Mountains. Still, rain that falls in the Rocky Mountains ends up in the Mississippi River.

The Riparian Corridor

The narrow area alongside a stream that has its own special vegetation is called the **riparian corridor**. What plants you will find in a riparian corridor depend on where the river is: the continent, the climate, stream hydrology, geology, alkalinity of the soil, and many other factors. They contribute nutrients, shade, organic materials for small organisms to eat, soil stability, and habitat. They also contribute food for fish in the form of bugs dropping from branches.

Life

Every stream also carries life-forms, and the habitats in which they live. Plants, both visible and microscopic, fungi, larvae, crustaceans, mollusks, worms, fishes, mammals, and many other life-forms live in and utilize streams.

Diversity is key to the survival of a stream's life-forms. **Genetic diversity** must be present within each species. **Species** and **biological diversity** must be present as well--many different types of animals. None of these types of diversity can be created or fostered by humans. They are the products of millions of years of evolution by trial-and-error. Once they are lost, they cannot be re-fashioned by scientists. Finally, **habitat diversity** is essential. Each stream contains many different habitats and microhabitats. A single species may require several different habitats to carry out its life functions, and each habitat is inhabited by its own species that cannot live elsewhere.

Floods

Floods are natural events, but their influence on river ecology is subtle. Animal and plant communities in rivers have spent millions of years adapting to the conditions around them, and floods have become simply a part of a larger cycle of river ecology for them. Riparian corridors depend almost exclusively upon their streams' flooding cycles for their existence. Many fishes wait until the first sign that the annual spring flood has begun to start **breeding**. Many insect larvae wait for flooding to begin to **lay eggs, hatch, or metamorphose**. Flooding provides a bonanza in cheap new **food sources** for stream denizens. Floods flush insects, bugs, and worms that used to be on land into the stream, which become dinner for fishes. Flooding results in increased **fertility** for the river. The more fertile a river, the more invertebrates will be able to live in it--and invertebrates form the base of the foodchain. Nutrients (like nitrogen and phosphorus) are washed out of soil and animal feces. Nutrients, added to the shallow, warmer waters of the floodplain lead to extra growth of **plankton**. Floods also wash dead brush and trees into the stream, providing **habitat** for countless animals.

Channelizing

When a river is prone to flooding, or to meandering out of control and across property lines or roads, we usually **channelize** it. We may dry up whole sections of river in order to bulldoze it into a tidy, straight line of water, and protect ourselves from its unruly behavior by lining the new channel with concrete or riprap (small boulders crated by truckloads and dumped along the sides of water channels). Unfortunately, this kind of channelizing leads to loss of habitat, as well as increasing the destructive potential of the river.

When towns grow up on floodplains, the annual flooding of the river and the changing of its course will bother the residents, and they will do what they can channelize it. This is a no-win situation for everyone concerned. The river becomes poor in nutrients and poor in habitat, and finally poor in organisms. This means it will no longer support the kind of fish that people like to see in their rivers, although it may often support fish that are not so welcomed by people, like carp. And the townspeople lose, too, because ironically, the more you try to channelize a river, the more out of control it becomes. Erosion, a minor irritant before, threatens property, buildings, and roads. The unique physical properties of water give rivers powerful force.

Water gathers energy as it flows downhill. When a stream meanders, it creates banks. The water then 1) pushes against the banks, and 2) swirls in eddies. In both cases, the energy of the flowing water is decreased. When a stream is channelized, however, there is nothing to prevent it from gathering more and more destructive energy as it flows downhill.

It is very important to realize that apart from completely cementing a river in, there is no way to control this increased energy. It will continue to attempt to break out of its channel. It may succeed during a rainstorm, with potentially devastating consequences.

Development

We also change our rivers by changing the land around them. If we pave land or remove vegetation from it, rainwater runs directly off of it instead of soaking into the earth. This **urban runoff** carries pollutants like car oil and pesticides instead of nutrients. When we change the vegetation around a stream, we change its chemistry. For instance, a developer may cut down all the trees around a stream in order to place a big neighborhood of houses next to it. This has many effects, among them that no more leaves will fall into the stream, taking out the very base of the stream's foodweb. Tree branches will no longer shade the stream and it will become too warm for the fish that belong there, and choked with algae. In addition, without overhanging branches, bugs will no longer fall from them to feed fish. The trees themselves were critical to that stream because they were providing nutrients to it, as well as shade for the growth of other important streamside vegetation. And finally, without the roots of vegetation to anchor streamside soil, the soil will become eroded away by the stream--forcing homeowners to channelize the stream.

When Hurricane Katrina hit, the entire world witnessed one of the consequences of channelizing rivers in order to build more houses in floodplains, as New Orleans and many of the surrounding parishes sank beneath floodwaters. Speculators and politicians have made a good business out of draining the swamps and marshes of the Mississippi River's delta in order to build new developments. In order to keep the land dry, they've laced the delta with channels that carry the countless streams of the delta out to sea. River deltas always sink, because the sediment that their rivers have deposited on them (through these little streams) over the millennia is very heavy. The streams, however, keep meandering and depositing more sediment, thus building the deltas up even as they are sinking. It is a balance that keeps deltas from ever sinking below sea-level. Now that the streams of the Mississippi Delta have all been channelized, however, no new sediment gets deposited--and the delta has begun to well and truly sink into the Gulf. Levees were built to protect the city and parishes from storm surge caused by hurricanes, but as everyone can now see, once the levees are breached the result is unmitigated disaster. (An event that had been predicted by scientists and ignored by developers and politicians).

Logging

As wooded areas become popular places to live, logging increases in order to build more homes. Logging in itself is not always such a harmful thing to streams: it is the logging roads that must be built for the logging trucks that do the lion's share of the damage. Silt from these dirt roads washes down the hillsides with the rain and enters the river, choking the substrate by filling in the spaces between gravels and cobbles of the streambed. This eliminates an important habitat of many of the aquatic insects that fish eat. Without habitat, the insects disappear. It also makes the maturation of salmon and trout impossible. Salmonid eggs (and later the very small juvenile salmon, or alevins) spend their early lives buried in streambed gravels, sheltered from the river's current and hidden from predators. They live off their yolks until they are large enough to fend for

themselves, before emerging into the water column. While they are still in the gravels, water must flow rapidly over them to bring them fresh, dissolved oxygen and to carry their wastes away. When silt from development fills in the spaces between the rocks, salmon and trout can no longer grow there.

In some rivers in America, especially those that run through clay soils, silt from logging--or, more often, from farming and development--can cloud up the river, blocking light. When light is blocked from a river, a whole different set of plants and animals grows and the original community is lost. Carp (*Cyprinus carpio*), a fish that is not native to America but has populated many of its streams and lakes, will also silt up rivers as it roots about in the mud looking for food.

Urban Runoff

After land is logged (unless the loggers own the land), people start to move in, filling up the drainage basin with buildings and pavement. This means that there will be more oil, and more lawn fertilizer, herbicides, and pesticides, than ever. It also means pollutants will run straight into streams more than ever. And because each house must have a sewage system to dispose of its inhabitants' wastes, these sewage systems will eventually fail, leaking their contents into the drainage basin and then into the river. Where city sewer is provided, treated effluent will be discharged directly into the river. Pollutants from this urban runoff, leakage, and disposal include chemicals that **fertilize** the river, changing its ecological balance, chemicals that **kill** bugs and algae that form the bottom of the foodchain, chemicals that build up in animal tissues to later **poison** humans and predators, and even prescription medications like Prozac.

The Future

We have not yet destroyed our rivers, although very few remain in their original condition. Disaster looms for many of them. The science of river ecology has advanced. We are learning to build logging roads in ways that minimize erosion, to locate mining operations more wisely, to control runoff from industry and agriculture, to maintain riparian (vegetated) zones around rivers, and to allow them to flow naturally. We are attempting to protect fish species that have been listed as endangered species.

Unfortunately, scientists cannot do these things alone, and they daily battle huge corporate, bureaucratic, and political obstacles to environmental improvements. The United States's environmental agencies have been rendered almost completely ineffective due to relentless pressure from extremely powerful and wealthy persons. In the end, only the citizens of a country, working together, will be able to protect their streams from ecological destruction.

The biggest job remains with you and me. Human population growth continues, placing ever more pressure on our streams and rivers. It is up to each of us to take measures in our personal lives that will assist them in remaining healthy for our children to enjoy.

Habitat Assessment

Stream Name: _____

County: _____ State: _____

Investigators: _____

Site (description): _____

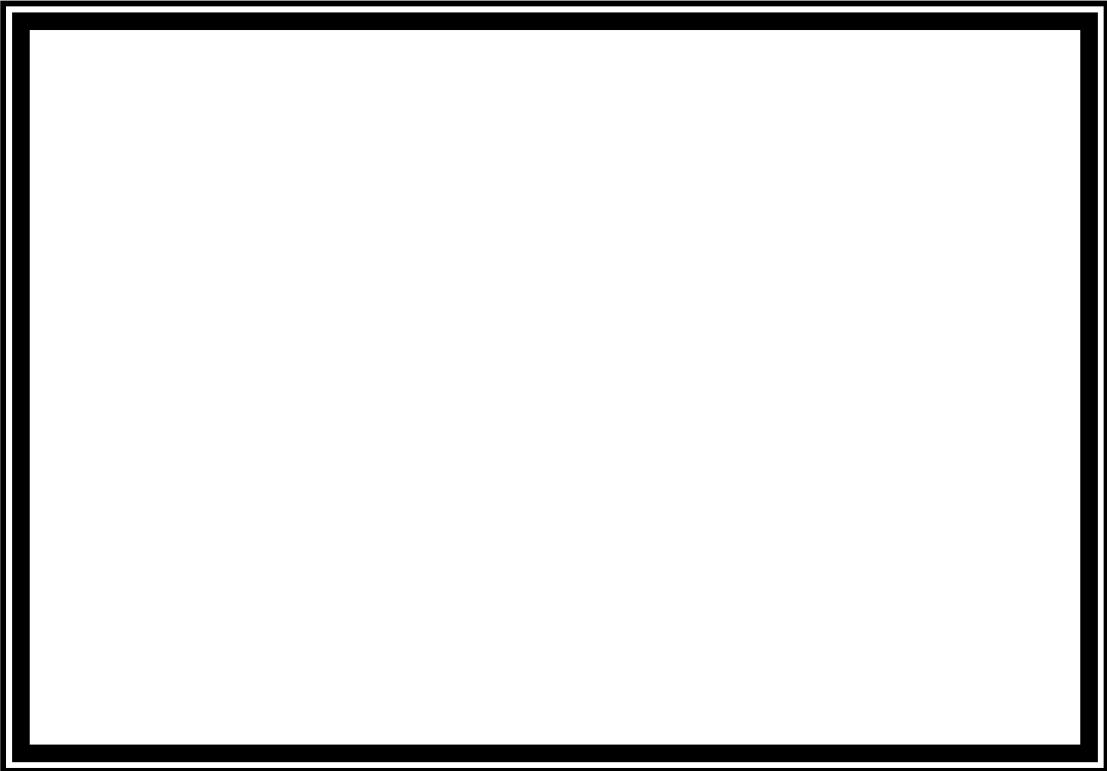
Latitude: _____ Longitude: _____

Site or Map Number: _____

Date: _____ Time: _____

Sketch or Description of Site

Note features that affect stream habitat, such as: riffles, runs, pools, ditches, wetlands, dams, tributaries, landscape features, logging paths, vegetation, and roads.



Water Chemistry

Temperature: _____

Conductivity: _____

pH: _____

Dissolved Oxygen: _____

