The Big River Ecosystem

Teacher's Guide

KENTUCKY DEPT. OF FISH & WILDLIFE RESOURCES

INTRODUCTION

Welcome back to the aquatic world of Rick Hill. This visit is not for the feint of heart nor the weak swimmer. We are venturing into the exciting world of the Big River: deep, mysterious, and home to big fish. We could put a specific river's name on it but in essence it could be one of several rivers. Pick one; it may flow next to your town, your school, your home.

Big rivers are the end result of very large scale watersheds. Just as rainfall runs from the roof of our home or school, it is "shed" by the earth. The rate it flows into streams is determined by degree of vegetative cover, slope of the land, and human land uses. Each area which drains rainfall into a given stream is defined as that stream's watershed. Therefore, a big river's watershed includes all land which drains water into feeder streams and rivers which flow into that river. The Mississippi watershed is the largest of the United States as it includes that land mass which drain into the Missouri, Ohio, Tennessee, and Arkansas rivers to name but a few.

The basic goal of the aquatic ecosystem poster series is to educate all people on the importance of healthy aquatic systems and their relationship to lifelong aquatic recreation. Therefore, this guide will stress positive aspects of what we recognize as national biological treasures. When students receive a negative picture of one portion of the environment, they may give up and look for something where their generation can make a difference. By informing and exciting them about "mysteries of the deep", perhaps the rivers of Kentucky will be that environmental challenge they will want to answer. To maintain balance, a reality section will be included to give teachers factual answers to anticipated questions about our big rivers as we enter the 21st century.

There are four teaching sections in this teacher's guide. First, each species featured on the poster is identified by common and specific name for users. Next, we establish large scale watershed concepts and how each segment of a watershed contributes to the Big River. The ancient fish section is intended to call attention to this unique group of fish and what is happening with them today. Finally, we illustrate human interactions with rivers and the economic importance of these rivers to our nation.

For Kentucky teachers, at least one KERA Academic Expectation from Kentucky's Curriculum Framework has been included for each activity. This is to illustrate the broad range of expectations that could be taught using individual activities or combinations. While one expectation is included, many others could be included. To improve our ecosystem efforts, please fill out the evaluation on the next page and return it to the address listed. Additional teaching ideas are requested and will be included in future publications of this teacher's guide when received. Send all comments to:

Aquatic Education Administrator
KY Department of Fish and Wildlife Resources
#1 Game Farm Rd.
Frankfort KY 40601
(502) 564-4762/FAX (502) 564-6508/e-mail lnelson@mail.state.ky.us

EVALUATION

Name: ____________________________ Grade taught: ______________________
School: ____________________________ Phone: ______________________
Address: ____________________________ e-mail ____________________________________
____

1. I received my Big River Ecosystem poster and teacher's guide from the following source.
____

2. On a scale of one to ten, please evaluate the poster in comparison to similar materials you have received.

1 2 3 4 5 6 7 8 9 10

3. What did you like most or least about the poster to rate it as you did?
____

4. How have you used this poster?
____

5. On a scale of one to ten please evaluate the teacher's guide you received in comparison to other similar products?

1 2 3 4 5 6 7 8 9 10

6. What did you like most or least about the teacher's guide to rate it as you did?
____

7. What other aquatic related materials would you find useful in your class or youth group?
____

ADDITIONAL COMMENTS (PLEASE INCLUDE HERE ANY ACTIVITIES YOU HAVE DEVELOPED FROM THIS POSTER):

I REQUEST THE FOLLOWING:

_____ Contact me with Project WILD training opportunities.
_____ Place me on a mailing list for future materials.
_____ Please send _____ extra copies for teachers at my school.
_____ Other

COMMON AND SPECIFIC NAMES,

For position, refer to graphic on poster.

	COMMON NAME	SPECIFIC NAME
1.	Midge	*Chaoborus* spp
2.	Green darner dragonfly	*Anax junius*
3.	Osprey	*Pandion haliaetus*
4.	Ring-billed gull	*Larus delawarensis*
5.	Black-crowned night heron	*Nycticorax nycticorax*
6.	Cottonwood	*Populus deltoides*
7.	Stonefly	*Pteronarcys* spp
8.	Burrowing mayfly	*Hexagenia* spp
9.	Mooneye	*Hiodon tergisus*
10.	Skipjack herring	*Alosa chrysochloris*
11.	Longnose gar	*Lepisosteus osseus*
12.	River shiner	*Notropis blennius*
13.	Paddlefish	*Polyodon spathula*
14.	Silver lamprey	*Ichthyomyzon unicuspis*
15.	Emerald shiner	*Notropis atherinoides*
16.	White bass	*Morone chrysops*
17.	Smooth softshell turtle	*Apalone mutica*
18.	White crappie	*Pomoxis annularis*
19.	Threadfin shad	*Dorasoma petenense*
20.	Blue catfish	*Ictalurus furcatus*
21.	Carp	*Cyprinus carpio*
22.	Spotted bass	*Micropterus punctulatus*
23.	Dragonfly nymph	*Anax junius*
24.	Highfin carpsucker	*Carpiodes velifer*
25.	Blue sucker	*Cycleptus elongatus*
26.	Shovelnose sturgeon	*Scaphirrhynchops platyrrhynchus*
27.	Smallmouth buffalo	*Ictiobus bubalus*
28.	Bluegill	*Lepomis macrochirus*
29.	Midge larva	*Chaoborus* spp
30.	Freshwater drum	*Aplodinotus grunniens*
31.	Armored rock snail	*Lithasia armigera*
32.	Pointed campeloma snail	*Campeloma decisum*
33.	River darter	*Percina shumardi*
34.	Butterfly mussel	*Ellipsaria lineolata*
35.	Crayfish	*Orconectes rusticus*
36.	Sauger	*Stizostedion canadense*
37.	Mapleleaf mussel	*Quadrula quadrula*
38.	American eel	*Anguilla rostrata*
39.	Silver chub	*Hybopsis storeriana*
40.	Stonefly nymph	*Pteronarcys* spp
41.	Gizzard shad	*Dorosoma cepedianum*
42.	Burrowing mayfly nymph	*Hexagenia*
43.	Washboard mussel	*Megalonaias gigantea*

Raindrops Keep Falling On My 'Shed

Each time rain or snow falls on Kentucky, a contribution is made to a perpetual flowing system: The Mississippi River Watershed. To get there, resultant runoff water may take many different paths through varied habitats but it all ends up in the Mississippi. At first, it drips or oozes through vegetation, soil, or along rocks. Then water begins to flow in a depression which carries water only after the storm. When these small rivulets meet and form a continually flowing stream, a "first order stream", we have the beginning of the river continuum.

The Mississippi river watershed has literally thousands of these small streams which contribute to the flow. To find them you must find local maps such as topographic or county maps. The state or national maps will depict the major systems but the first order streams are too small to be shown on large scale depictions.

Every headwater stream in the watershed has a unique "signature". Nutrients and suspended vegetation are specific to that land mass. Initially, there is little aquatic plant growth so the initial part of the food chain depends on food that falls or is washed into the stream. This vegetative material is processed by animals, primarily insects such as stoneflies, called "shredders". Small particles which are not eaten by shredders are eaten by "collectors" i.e. mayflies. Most fish that live here are small predators such as darters or dace which feed on the insect larvae. With a limited amount of plant material, the animal community is usually limited in headwater streams.

Mid level streams (stream order 4-7) have both rooted and suspended aquatic plants and many more types of animals have a niche in which to live. "Grazers" such as caddisfly larvae, snails and water pennies eat the growing plants while collector numbers increase with the varied plant life. With more water and plant growth, shredders become less dominant at this level. While many fish species from headwater streams are still present, the number of species of fish found in these streams increases. Many fish living in these streams are actively sought by anglers. This is partly because these are considered the "wadable streams" which satisfies adult desires to wade as we did as children. It is important to note that individual watersheds only a few miles apart can have significantly different varieties of animal life. This is dependent on the watershed and what has happened naturally over time, or recently through human intervention.

When streams meet, mix, and proceed downstream, individual characteristics of the smaller streams combine into a big river. Nutrients from each watershed are now melded into the deep water. Shredding of material is again less dominant and rooted plant growth is diminished because of water depth. Collector species are more dominant in this ecosystem. One major group of collectors are the mussels. Fish species include those which specialize in microorganisms such as the paddlefish, shad or the sucker family. Of course, there are also predators from all animal classes. These range in size from plankton to blue catfish.

The discussion of plants and animals in each segment refers to the "species" biodiversity of a specific watershed. Rivers are part of larger scale ecosystems, and those organisms which are related to the water contribute to the "ecosystem" biodiversity of that particular region. As rivers and associated aquatic life are intertwined with all living creatures throughout the watershed, the product becomes "landscape" biodiversity.

As you imagine a big river watershed, you can see how isolated or widespread storms affect the ecosystem. Thunderstorms may seem intense in a given community, but may hardly cause a ripple in the larger river. However, a sustained rain or rapid snow melt throughout the watershed can cause major fluctuations as each small river contributes. The combined effect of floods in nearly all watersheds was devastating for Kentuckians in March 1997. When rivers such as the Salt or Green rivers emptied into an already flooded Ohio River, high water levels in the Ohio became an obstacle for escaping water which caused the tributaries to back up and compound flooding.

For human related effects on the river continuum, see the "I Am, Therefore I Tinker" of this teacher's guide.

In addition to the following recommended activities, teachers could also consult with other organizations for teaching materials on rivers. The Tennessee Valley Authority (TVA) has several curricula, Isaac Walton League also publishes guides, and U. S. Environmental Protection Agency published "Always a River", a supplemental environmental curriculum on the Ohio River and water, in 1991. For advanced classes, Kentucky's Division of Water is writing a Watershed Management document which is in the draft form at this writing. Future corrections to this teacher's guide will include appropriate reference.

STUDENT PROJECTS:

1. See "Where Does Water Run Off After School?" from Project WILD, Aquatic edition. How far does the water travel from the school yard before it enters a flowing stream or river? This provides the students with their watershed address. Have them estimate where this stream is in the river continuum. Based on their estimates, what type of life processes would they expect to find in the stream or river. If possible, have them sample the water to identify the plant and animal life to substantiate their hypothesis. For sampling techniques see "Water Canaries" of Project WILD, Aquatic.

This exercise can be adapted for all ages. Sampling is best for grades 6 and above depending on degree of reporting expected. KERA Academic Expectation 2.3: Students identify and describe systems, subsystems, and components and their interactions by completing tasks and/or creating products.

2. Using Aluminum foil on table tops, have students build two sections of "stream" which come together to form a larger aluminum stream. Pour very thick chocolate milk (too much syrup) into one stream and plain milk into the other. Watch the resulting mixing. When they combine, do they immediately mix or do they stay separate for some distance? Have the resultant stream flow over the table's edge (like a waterfall) into a clean container to thoroughly mix the "streams' flow" and serve liberally with cookies! If milk and cookies are not part of the curriculum, use different colored water in each segment.

Best suited for students in grades 1 to 5 with student participation best at older ages. KERA Academic Expectation 2.4: Students use models and scale to explain or predict the organization, function, and behavior of objects, materials, and living things in their environment.

3. Interview older members of the community and ask them about the local watershed. A few sample questions are included, however, students should be encouraged to be creative.

A. How long have you lived in this watershed?

B. What land use changes have you seen in the watershed that affect the river?

C. What flood events stand out for you and what was the main cause of each flood?

D. Has recreation changed on the river in your life?

E. What advice would you offer to today's students in regards to the future of the community and the river?

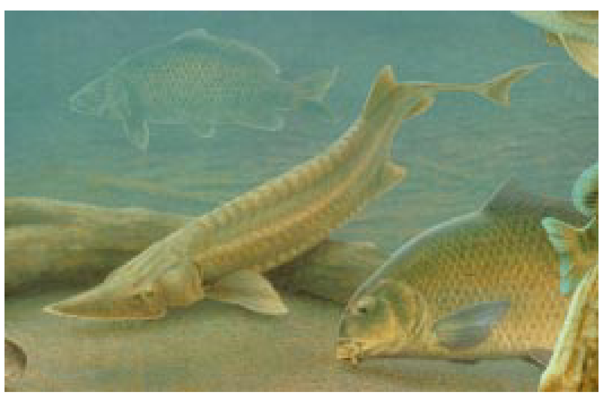
After students complete their survey, have them summarize the findings in a report.

These could be combined in newspaper fashion (students applying computer skills) with different students assigned to key issues.

This exercise is best suited for students from grades 5-8. Older students may want to write individual reports based on the findings of their survey. KERA Academic Expectation 1.11 and 1.12: Students communicate ideas and information to a variety of audiences for a variety of purposes in a variety of modes through writing (newspaper) or speaking (interviews)

Fish From The Time Of Dinosaurs

It is indeed difficult to imagine what the world was like when dinosaurs roamed the earth. However, several fish species depicted on the Big River Ecosystem poster were present long before Tyrannosaurus Rex. In fact, lamprey, as shown attached to the paddlefish, are present in fossil records from about 320 million years ago, and they really haven't changed much over that time. Others in the poster which are considered survivors of that time include the gar, sturgeon, and paddlefish. While scientific evidence doesn't discuss them as ancient fish, eels will also be discussed just because the author thinks they are neat!



ADAPTABILITY

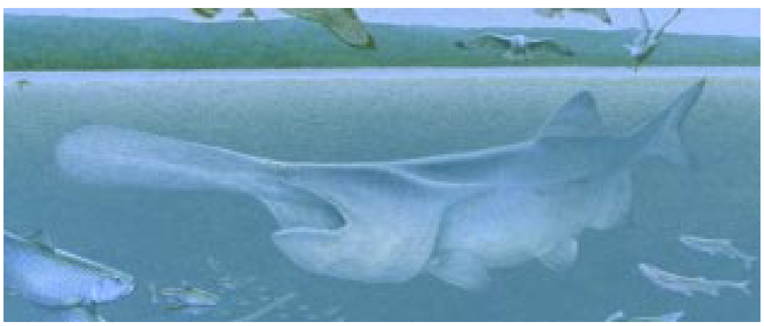
The very fact ancient species have survived eons of natural disasters speaks highly for their adaptability. These fish adapted to gradual changes and survived local catastrophes (such as volcanic eruptions) because their adaptive styles allowed them to use various rivers. If water temperature or volume altered their existence in one area, the species would thrive in another system. When the river returned to acceptable conditions a few thousand years later, migration could repopulate the altered ecosystem as habitat allowed. Because the fish are essentially the same as their representatives in fossil records, this is considered an adaptive trait rather than genetic changes.

While we can only imagine what the rivers were like in prehistoric times, we know our ecosystems today are drastically different than they were even in 1900. These changes are occurring over wide regions of the world and at a very rapid pace when compared to geological changes. One good example is the building of reservoirs and the effects on migratory species. Two species that are affected by reservoirs are paddlefish and eels. Only within the past few years have we understood that reproduction of paddlefish is related to flooding. Reservoirs were primarily built to prevent flooding and may be inhibiting paddlefish reproduction in some areas. Eels are essentially prevented from migrating to certain areas by reservoirs which serve as total barriers. There is no evidence that this is adversely affecting the population of eels, but because eels only reproduce in the Sargasso Sea, between Bermuda and the Bahamas, they are excluded from many headwater streams by reservoirs.

Because these fish have survived the eons of natural changes, as scientists we can predict they can also adapt to humans if we continue to monitor the effects we are having on each species and the total ecosystem. Our awareness of water quality has increased greatly since about 1970, and with new generations of informed citizens growing into adults, we can be optimistic for these adaptable species.

STRANGE AND WONDERFUL CHARACTERISTICS

While every species has unique characteristics which make it special, ancient fish are especially interesting and mysterious. Paddlefish from the Mississippi river system can exceed two meters (6.5 feet) long while their cousins in the Yangtze river of China may reach five meters. Sturgeon of the Mississippi watershed are not usually extremely large, but the beluga sturgeon from Russia is generally considered the largest freshwater fish (although the largest in fact spend some portion of their lives in the sea) in the world reaching lengths of 8.5 meters (28 feet) and weights of



1300 kilograms (2860 pounds).

Paddlefish and sturgeon depicted in the poster may not reach the size of their Asian counterparts, but they share other features of interest with those relatives. Rather than having true bones, their skeletons are made of cartilage, similar to sharks. Sturgeon use barbels to locate food which is mainly invertebrates from the bottom of the river. Shovelnose sturgeon may even use their nose to disturb the decaying matter or detritus to facilitate eating. Paddlefish are filter feeders which engulf large volumes of water and remove plankton using specialized gill rakers. Both of the fish will eat small fish when they have the opportunity, especially when individual sturgeon or paddlefish are larger.

Gar and sturgeon both have scales which resemble bony plates found in reptiles. While the sturgeon large scales are called "scutes" they are remnants of ganoid scales such as those found on gar. Ganoid scales, unlike the scales of modern fish, contain dentine which makes the scales very difficult to penetrate. These scales once again offer the comparison for children to dinosaurs such as Triceratops.

EELS AND LAMPREY, THIS IS YOUR LIFE!

Just as individual humans seem to have more or less interesting lives, so do some species of fish. Most fish hatch from eggs in a form that greatly resembles the adults and live in the same habitat used by the adults of the species. Eels and lamprey, in contrast, have life histories that are remarkable (well, maybe just plain interesting).

As mentioned earlier, all freshwater eels (from both Europe and North America) spawn in the Sargasso Sea. The young of the year hatch into "leptocephalous" larva then drift with ocean currents for approximately one year (North America) before they transform into elvers (larva drift for up to three years before reaching Europe). Elvers migrate upstream in major rivers where they live as greenish or yellow eels for 6 to 12 years. They then transform into "silver eel" and migrate back downstream, follow deep ocean currents to the Sargasso Sea, spawn, and die. This is all the more remarkable when one considers the North American and European eels are considered distinct species yet use the precise same spawning grounds.

While lamprey are often regarded with the same adoring qualities of vampires and leeches, their life cycle is more than simply sucking blood from a victim. After adults

spawn, the larvae drift downstream to a muddy backwater and live a secretive life buried in the mud bottom of streams or wetlands for several years. During this time, lamprey larvae live on the decaying matter on the stream bottom (and we thought they were unattractive as blood suckers). These two distinct forms were thought to be separate species until 1856 when the relationship was discovered. Another interesting point to remember is that not all lamprey are parasitic or predatory. However, when we apply lampricides (chemicals to kill lamprey) as has been done in the Great Lakes region to protect commercially valuable fish, we kill all lamprey to get the guilty.

STUDENT PROJECTS:

1. See Aquatic Wild, "Fashion a Fish". Have students draw their ideal fish for the future based on what they have learned from the Big River Ecosystem poster and the traits exhibited by these ancient fish. Each child or group should explain why they used certain parts to make their fish more survivable.

This exercise is recommended for K-12, students in lower grades could also be encouraged to "dress up" as their fish. KERA Academic Expectation 1.13: Students construct meaning or communicate ideas and emotions through the visual arts.

2. Have students compare the ancient fish of the poster with extinct fish such as ostracoderms or placoderms. Why did those fish become extinct while the depicted ancient fish survived? What are the characteristics we could identify which may become limiting factors for the ancient fish? What needs to be done to prevent them from declining in numbers and possibly going extinct in the next 100 or 200 years?

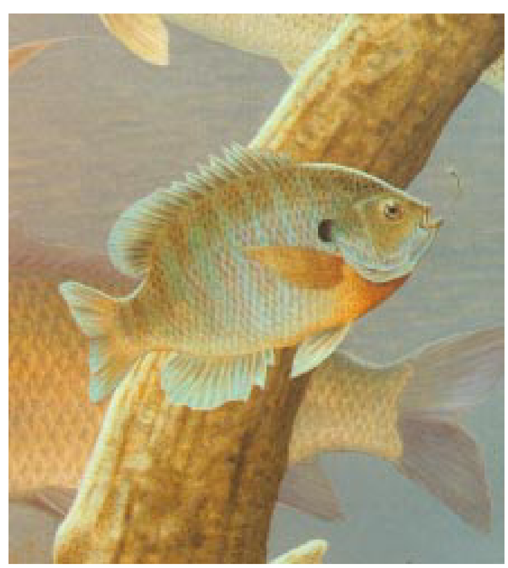
Because of the finality and seriousness of extinction, this exercise is recommended for older students, seventh grade and older. KERA Academic Expectation 2.6: Students complete tasks and or develop products which identify, describe, and direct evolutionary change which has occurred or is occurring around them.

3. You are what you eat! Do a research project on the adaptive feeding styles among the ancient fish. How did feeding behavior contribute to long termed survival of each species? What adaptive characteristics do these fish have which prevents them from being at the "consumed" level of the food chain? Are there factors related to the food chain today which students should relate to future survival of these species?

This exercise could be used by grades 4 to 8. KERA Academic Expectation 2.6: Students complete tasks and or develop products which identify, describe, and direct evolutionary change which has occurred or is occurring around them.

4. Research human consumptive features of ancient fish. How many anglers pursue these fish? Which are considered "gourmet" dishes? (Eel, lamprey, and caviar from sturgeon and paddlefish are all gourmet foods.) Which cultures use these fish? Why aren't gar eggs included in caviar jars? Has that contributed to survival of gar? What is the potential for raising these fish in controlled lakes for human consumption?

This exercise could be used by older students grades 6-12. KERA Academic Expectation 2.30: Students demonstrate effective decision-making and evaluate consumer skills.



I Am, Therefore I Tinker

This section addresses human interactions with big rivers. It is the intent of the writer to present a balanced viewpoint. A prime theme as we enter the 21st century is sustainable development, and rivers offer students (tomorrow's adults) a challenge to maintain the river and its natural qualities as we develop the nation economically. Each type of interaction discussed will offer a cost/benefits analysis for both humans and aquatic animals.

RESERVOIRS

Reservoirs are man-made impoundments and range in size from small farm ponds to huge lakes. The primary purpose for Kentucky's large reservoirs has been flood control but they also offer many other opportunities. Not only is fertile river bottom land protected directly from flooding, in some areas of the country the water is diverted into irrigation systems to provide a more reliable flow of water through the growing season. Hydroelectric power, generators powered by flowing water, is produced at many of our reservoirs, and impounded water is often used as sources for community water supply. Finally, tourism and recreation on the large impoundments is an important part of the economy.

The primary costs to the human community when we build a reservoir are monetary. Not only does the construction and associated physical structures cost a great deal, that land which is flooded is permanently lost for crop or timber production. Where we have built reservoirs, occasionally whole towns have been relocated with the resultant loss of history and family culture.

From the aquatic animals viewpoint, it depends on the animal's life requirements. Each species is more suited for one habitat than another. Each aquatic animal has specific water factors in which it is best suited. Some species which were in the river system before reservoirs depended on high water conditions for reproduction. Wetlands replenished by floods were a place for young of the year to grow. Reservoirs permanently flood riverine wetlands and reduce flood events which decreases the opportunity for these species to continue using that river. However, other species found in the impounded river may do better in reservoirs than in steadily moving water. Generally speaking, those species capable of adapting rapidly will be the most abundant in the altered environment.

The water in the river below the reservoir is also changed. When water comes from the bottom of the reservoir, it maintains a cold water discharge throughout the year. Species which need a warming trend for specific life processes such as reproduction may not find the river suitable for many miles below a reservoir. However, this cold water creates an environment where other animals which were not indigenous to Kentucky, such as trout, will survive. This creates a desired opportunity for anglers and adds substantially to the tourism economy.

COMMERCIAL TRANSPORTATION, LOCKS AND DAMS

From the earliest settlement of Kentucky, our rivers have been major transportation routes for products being shipped from the state. As boats and barges became larger, we dredged channels and installed locks and dams on many rivers to allow safe navigation. This transportation system was a major factor in developing the coal industry in Kentucky. While trains and trucks now transport many industrial products, river barges still carry commercial products up and down our major rivers.

The dam creates a pool in the normal river channel which is deeper than the flowing river would have maintained. The barge enters a lock which is then flooded from the pool to raise the barge to the pool level. It then proceeds upstream to the next lock where it repeats the process. Going downstream, the barge enters a lock, which is drained to lower the barge to the river level below the lock.

Like reservoirs, money is required for a lock and dam system, but there is normally very little productive land lost due to pooling of the river in comparison to reservoirs. However, during floods, these dams do not provide flood control as a reservoir would, and flood water flows freely over the top of the lock and dam in navigation systems.

In each pool, the river is more like a reservoir than a flowing river. In a continuous flowing system, sediment would be deposited in specific areas which would develop into sand bars and islands. In pooled rivers, it settles uniformly over a large area which can potentially cover habitat for aquatic species. As in reservoirs, changes in water flow rate, temperature, and other characteristics favor some species while selecting against others. Sand bars, which are dredged to improve transportation routes, are a good example of wildlife habitat which has been commonly removed from the big river ecosystem.

BRIDGES

When we build a road across our major rivers, bridges are a necessity. We could not transport goods quickly and economically on highways without them. Historically, when we built bridges, the highway approaches often created an unintentional dike across the flood plain. When major flood events occurred, flood waters had to escape through the small opening covered by the bridge while water which would normally have flowed down the flood plain was restricted by the "dike". At times, this amplified the flood event upstream from the bridge. Today, engineers recognize this hazard, and caution is taken to allow rivers ample space for discharge of flood waters.

CHANNELIZATION/ DIKES

Channelization is a practice where rivers are straightened and deepened to allow water to escape more efficiently. Dikes are built on the shore to contain the water within a given area. Channels and dikes are sometimes used separately or can be used together to allow agricultural development of the floodplain or to protect urban areas. Both in urban and agricultural areas, there is a need to get the water out of the community to get on with our lives.

Rivers naturally meander or wind back and forth. While it is not a conscious decision on nature's part, this slows the water and decreases erosion. By building a channelized section, the water travels a shorter distance but still falls the same elevation. This increases the speed which also increases erosive power. To complicate erosion, trees are usually removed from channelized sections along with the tree roots which normally slow erosion. In urban areas, flow rates are increased by runoff water from the network of streets, roofs, and parking lots at malls, factories, and schools.

Dikes keep water within an expected area, but they disrupt the long term revitalization of wetlands and floodplain bottoms. Historical floods deposited the topsoil in these areas and they are some of the richest farmlands available. When flood events breech the dikes as happened in the 1993 flood of the Missouri/ Mississippi, the results are quite different than when floods spread evenly over the floodplain in ancient times. The swiftly moving water carries larger sediment particles and sand/ gravel bars may be deposited rather than topsoil. Where the water escapes, deep gorges may also be cut through previous fertile fields by the concentrated water.

When we channelize or dike several of the rivers which drain into the "Big River", the results are predictable. All affected communities send their water out of town and the main watershed receives more than it can handle.

In areas with reasonably high precipitation, the degree and frequency of high water events in a big river will predictably increase.

For aquatic animals, results of channelization and diking of rivers are not so predictable. One thing that is predictable is that a channelized river will not replenish wetlands within the watershed. In the river, some stretches will have swifter water, while some channels may be isolated into oxbow lakes. The natural system would have a series of riffles (shallow swift water) and pools (deeper slow moving water) at a predictable temperature. A given channelized segment of the river may have deep water part of the year and shallow, slow moving, warm water later. These habitat variations create a different aquatic community from what was found in the natural system. While some species may flourish, species biodiversity is usually decreased. There are cases, however, where channelized sections have increased aquatic life. As usual with nature, go figure.

STUDENT PROJECTS

1. Student activities may include "To Dam or Not to Dam" (Project WILD, Aquatic edition) or an exercise for cost/benefit comparison of a simulated or real community situation. For instance, there have been many recent flood events nationally. What caused the intensity of a given event, what is planned (reality) to avert future flooding, or what solution (simulated) might be proposed? Is there a difference when we do an exercise or when we have been directly affected by a disaster?

For a history lesson, go back in time and ask the students to decide whether to build an existing reservoir based on the information that existed at the time it was built. Now introduce current knowledge and see if there is a difference in decision making.

Recommended for grades 5-12 with more complex questions for older students. KERA Academics Expectation 2.19: Students recognize and understand the relationship between people and geography and apply their knowledge in real-life situations.

2. Use a state map to identify how your community is affected by people in the watershed. Who lives upstream and what activities occur in those communities that affect the student? Has the river been altered upstream by reservoirs, channelization, or other human actions? If yes, what are the effects at your point on the river? How many communities treat water from the river for human use and discharge their waste water into the watershed before it gets to your town? What agricultural activities upstream affect water quality in your town? Likewise, what happens in the student's community that affects the lives of residents who live downstream?

This exercise could be adapted for grades 1-8 with older students expected to provide more detail. KERA Academic Expectation 2.16: Students observe, analyze, and interpret human behaviors, social groupings, and institutions to better understand people and the relationships among individuals and among groups.

3. Have the students study the river continuum of their community down to the Gulf of Mexico. Plan a boat trip from the headwater streams all the way to the Gulf. Where could they first expect to float a canoe or raft without having to get out and drag it? What man made obstacles occur throughout the journey? Where would they expect to find waterfalls, dead fall logs, or sandbars which may create navigation hazards? Would they plan to fish or swim during their journey? When would they transfer to a bigger boat or possibly a houseboat? What type of eating and sleeping arrangements would they make with each boat? What would it be like to go through a lock and dam in different boats? What type of changes to the river ecosystem would they expect as they enter larger rivers or travel through other communities?

A culmination activity could be arranged with a canoe, raft or boat trip on a small segment of the associated watershed. Another potential field trip might include a visit to a lock and dam facility to witness the locking process.

This exercise is recommended for grades 5-8. KERA Academic Expectation 2.35: (Lifetime Physical Activities) Students demonstrate knowledge and skills that promote physical activity and involvement in physical activity throughout their lives.

GLOSSARY

Barbels - Sensory structures found on many fish near their mouths to help them find food.

Biodiversity - A term to describe the diversity of life or ecosystems.

Collectors - Animals which filter the water to remove small particles of food from the water column.

Detritus - A layer of decaying plant and animal material on the bottom of an aquatic ecosystem. Normally contains bacteria which aid the decay process.

Elvers - The stage of eels between the larval stage and adults swimming upstream in fresh water rivers.

Ganoid Scales - Scales that include dentine, the same material found in teeth.

Gill Rakers - Structures on the gills of certain fish which helps remove microscopic food particles from the ingested water or material.

Grazers - Animals which move from one growing plant to another to attain their food.

Indigenous - Having been found to naturally inhabit an area prior to human influence.

Leptocephalus - Literal meaning is a light or thin head. As used in this guide, it is a transparent oceanic larval stage of eels.

Niche - The position of an organism within an ecosystem. Defined by the chemical, physical, spatial and temporal factors required for existence. In simpler terms, habitat defines an animal's home, niche describes its address.

Ostracoderms - Heavily armored, jawless fish which have long since been extinct.

Placoderms - A group of extinct fishes which had a primitive jaw suspension and a functional pair of first gill slits.

River Continuum - The entire picture of flowing water in a watershed. Starts when water flows continuously in small streams and ends where the "big river" empties into the salt water.

Scutes - Bony plates of protective covering. On sturgeon, these are derived from ganoid scales or scales with dentine origin.

Shredders - Animals which derive their nourishment by shredding plant material such as leaves that fall into the water.

JUST THE FACTS, ALL I WANT IS THE FACTS

The following information is presented to inform teachers so they can be better prepared to answer questions from their students. Informed students and teachers will be much better decision makers for future development of the state. In 1992, The Kentucky Environmental Quality Commission published "State of Kentucky's Environment". It is a comprehensive evaluation of all environmental factors. That document is currently being updated and should be available by the end of 1997. Personal copies may be ordered from that commission at 14 Reilly Rd., Frankfort KY 40601 at $10 per copy or they will be available at public libraries.

To paraphrase the information in the 1992 report on rivers, we are better than we were 20 years ago, but we still have some work to do. The key is to recognize the increments that must be accomplished as we work together on environmental challenges.

POLLUTION

Pollution is a word which summarizes a variety of things that are happening in our environment. It is important to students to recognize the sources of pollution. Point source pollution is when a given "point" such as a discharge pipe can be identified. Non-point source pollution is when rain falls on a land mass area and the resultant runoff carries pollution into the waterway from the entire community.

Pollution factors are also variable. Chemicals are very helpful for controlling weeds or insects in our lawns, gardens or agricultural fields. However, when they are carried into the river, they can become pollution agents. Soil erosion is a natural event, but silt eroded during a storm event is also a form of pollution. While farms are thought of by most people as sources of soil erosion, urban communities contribute to erosion as housing or commercial areas are developed. Another factor of pollution is discharge of wastewater into rivers. Treated sewage adds nutrients while untreated sewage, such as straight pipe sewage, or treatment plant overflow, adds bacteria as well. A pollution factor that affects aquatic organisms is thermal pollution. Water may be heated by power plants or by the sun when rivers are channelized with shade trees removed.

The following table illustrates some pollution factors comparing 1991 and 1995.

Pollution Type	1991	1995
Bacteria/pathogens	34.5%	38%
Siltation	20.0%	21%
Organic Enrichment	13.1%	8%
Nutrients	7.8%	7%
pH	5.9%	13%
Chlorides	5.4%	Not listed
Metals	4.6%	3%
All others	8.70%	10%

ENDANGERMENT

The following information is again from the State of Kentucky's Environment. The number of species suggested by Nature Preserves differs from Federal Lists as some species are under consideration for listing and definitions of "special concern", "rare",etc. may differ. In Kentucky's aquatic environment, mussels are the group of organisms for which everyone is most concerned. All organisms which are dependent for some or all life functions on the bottom of the river system are of concern primarily due to settling of silt and other materials directly onto the habitat upon which they depend. The following facts, derived from Page 258 of 1992 version State of Kentucky's Environment illustrates the status of selected groups of aquatic animals.

1991 DATA: There are 103 mussel, 242

fish, and 105 amphibian and reptile species believed to have been in Kentucky. There were 11 mussels, 2 fish and 0 amphib/reptiles federally listed as threatened or endangered. Fourteen mussels, 10 fish and 4 amphib/reptiles were proposed to be listed. Fifteen mussels, 2 fish and 1 amphib/reptile were presumed extinct or extirpated. Of special concern for Kentucky are 39 mussels, 70 fish, and 38 amphib/reptiles.

1997 data is not available at this writing but will be included in future rewrites.

FISH CONTAMINATION

Each year the Kentucky Department of Natural Resources, assisted by the Kentucky Department of Fish and Wildlife Resources, monitors the contamination level of fish in selected habitats. (See page 14-16 of the March 1997 version of Water Quality, State of Kentucky's Environmental Series.) The results are passed to the public in the form of advisories to consuming fish in the annual fishing and boating guide. It should be understood that eating fish which is under an advisory does not mean the fish will cause the consumer immediate death or sickness. Different levels of certain toxins suggest specific consequences. Like many of our society's warnings, we want the consumer to be aware of the choice they make by eating the fish.According to the 1992 EPA National Study of Chemical Residues in Fish, eating 4 ounces of catfish from the Ohio River (where catfish is on the advisory list) every month for 30 years would increase the consumer's chances of getting cancer by 1 in 10,000 at the levels found at that time. Every American has a 2,000 in 10,000 chance already, so the chances are increased to 2,001 in 10,000. This is not intended to trivialize the contamination of these fish as it should not be eaten at all by pregnant women, women planning to have a family immediately, or children under 3 years of age. The important message is that we make choices in our consumptive habits daily, and many things people consume or use in their daily lives are much more dangerous than fish at this level of contamination.

A sobering fact is that some contaminants are not going away any time soon. Many existing chemicals have long half lives and will exist in the rivers for many decades if not centuries. These products accumulate in the fat of animals or in the reproductive systems (eggs). Those high in the food chain and those with high longevity will accumulate the most.

Preparation of the fish to be eaten affects the amount of chemical passed to the human consumer. As the fish is cleaned, all fat should be removed along with the blood lines next to the skin of filleted fish. When the fish is cooked, any method which allows melted fat to escape from the fish will decrease the amount of ingested chemical.

CONCLUSION

For complete information, this author strongly suggests research of the referenced documents as they give much more detailed information than can be given in this short synopsis. For students, the end product of their research should reflect how our society can develop while safely managing aquatic resources. We will probably not eliminate contaminants, but we must continue to eliminate new sources while we attempt to control the concentration at some acceptable level.

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