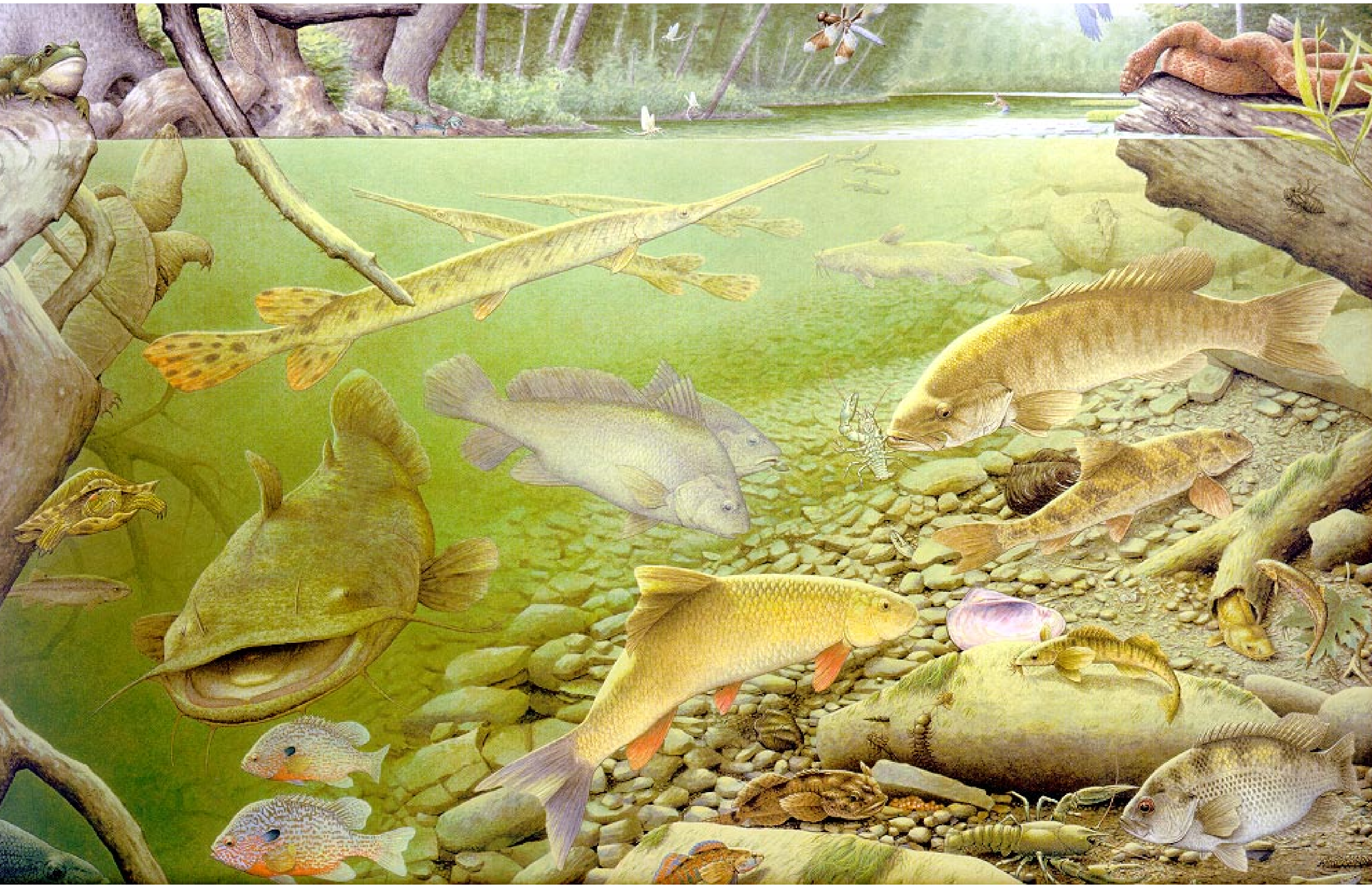
TEACHERS GUIDE STREAM ECOSYSTEM POSTER



Written by Lonnie Nelson, Aquatic Education Administrator
Kentucky Department of Fish and Wildlife Resources

INTRODUCTION

Welcome to the aquatic world of Rick Hill, artist for the Kentucky Department of Fish and Wildlife Resources. Having watched the development of this poster from its inception, I recommend you either hold your breath or use a snorkel!

The Stream Ecosystem poster represents a typical middle order (sixth to seventh order) stream. (When water first trickles into a running stream it is called a first order stream. When two first order streams join they become a second order stream. When two second order streams join they become a third order stream, etc. The largest order river in the United States is the Mississippi, a twelfth order river.) Species selected are representatives of this ecosystem; however, space prevents the inclusion of all species a scientist might hope to find in a specific stream. Those shown have been selected to depict natural variety, beauty and the importance of every stream species.

A stream is the scene of a natural drama including living and dying. The action shown would not normally occur simultaneously at one point but could be compacted into a short segment stretch of water in a short period of time. Those who have been on a river or stream at dawn with many fish active can testify to the excitement of multiple splashes and the mystery of who was fortunate and who was not.

This poster was created through funds from the Sport Fish Restoration Program. **The goal of the poster is to educate all people on the importance of healthy aquatic systems and their relationship to lifelong aquatic recreation**. The teachers guide is intended as an aide, but experience tells us teachers and youth leaders will expand the lessons through their resourcefulness. Each recommended subject has a discussion which is intended as information for the presenter. Activities follow which are primarily taken from Aquatic Project WILD.

To improve our future efforts, please fill out the form on the next page and help us evaluate. If you have additional ideas for including the poster in your lessons, please include them in remarks and they will be relayed in future editions. Send all comments to:

Aquatic Education Administrator
KY Department of Fish and Wildlife Resources
1 Game Farm Rd.
Frankfort KY 40601
Phone: (502) 564-4762 or 1(800) 858-1549

Name: ______________________________ Grade taught: ___________

School: ______________________________

Address: ______________________________ Phone # ___________

____

1. I received my Stream Ecosystem Poster 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 will you use this poster?

____.

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

1 2 3 4 5 6 7 8 9 10

6. What did you like most or least about the teachers 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 ACTIVITIES YOU HAVE DERIVED FROM THE 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.

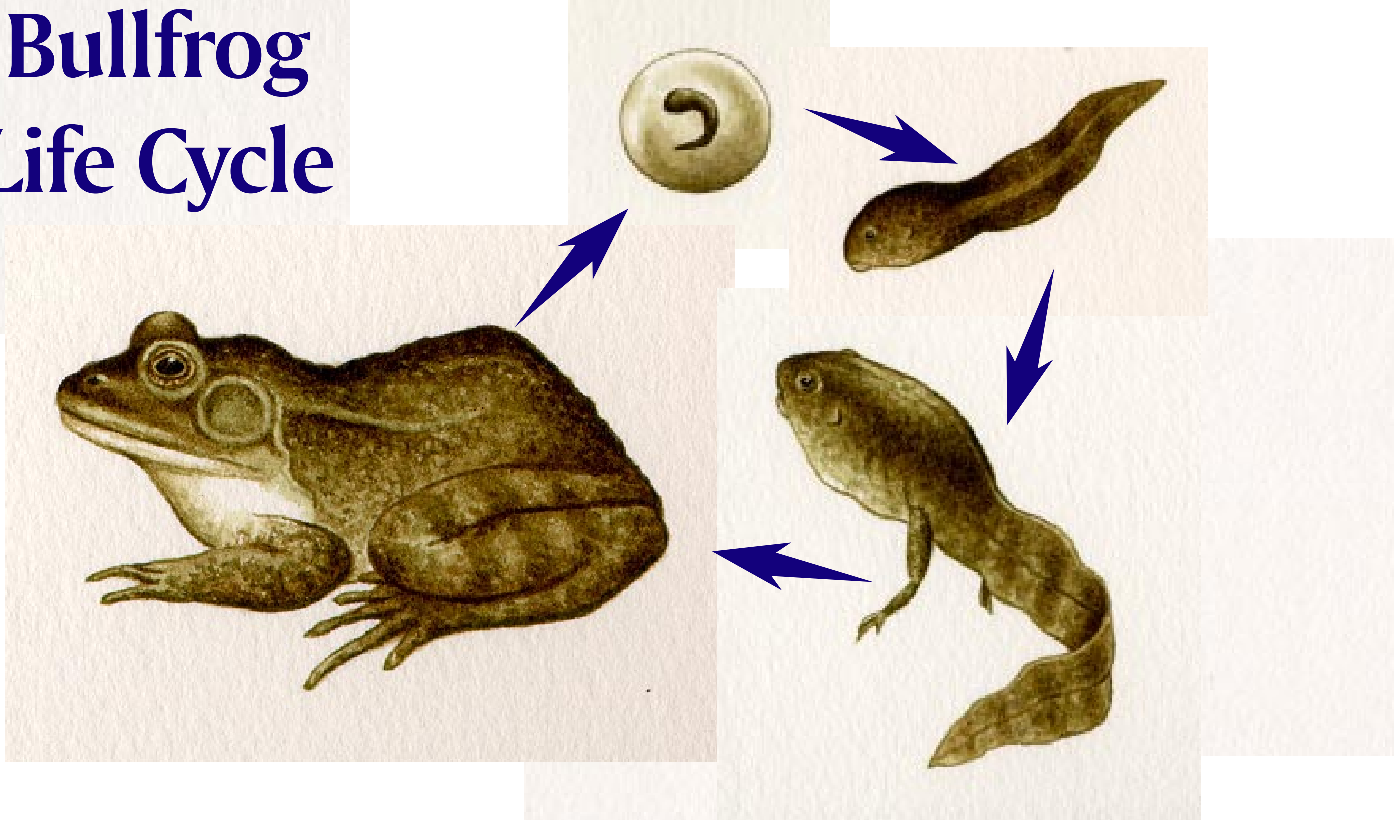
_____ Other

.

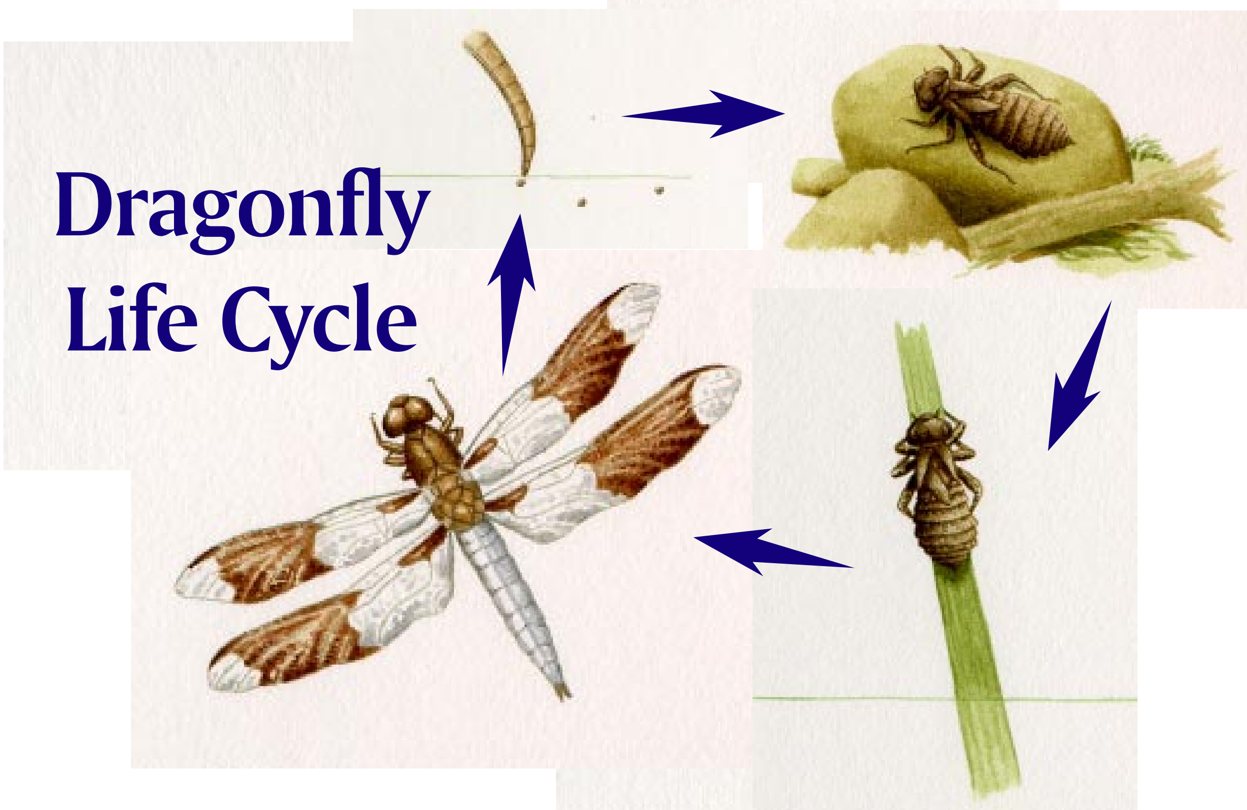
Notes

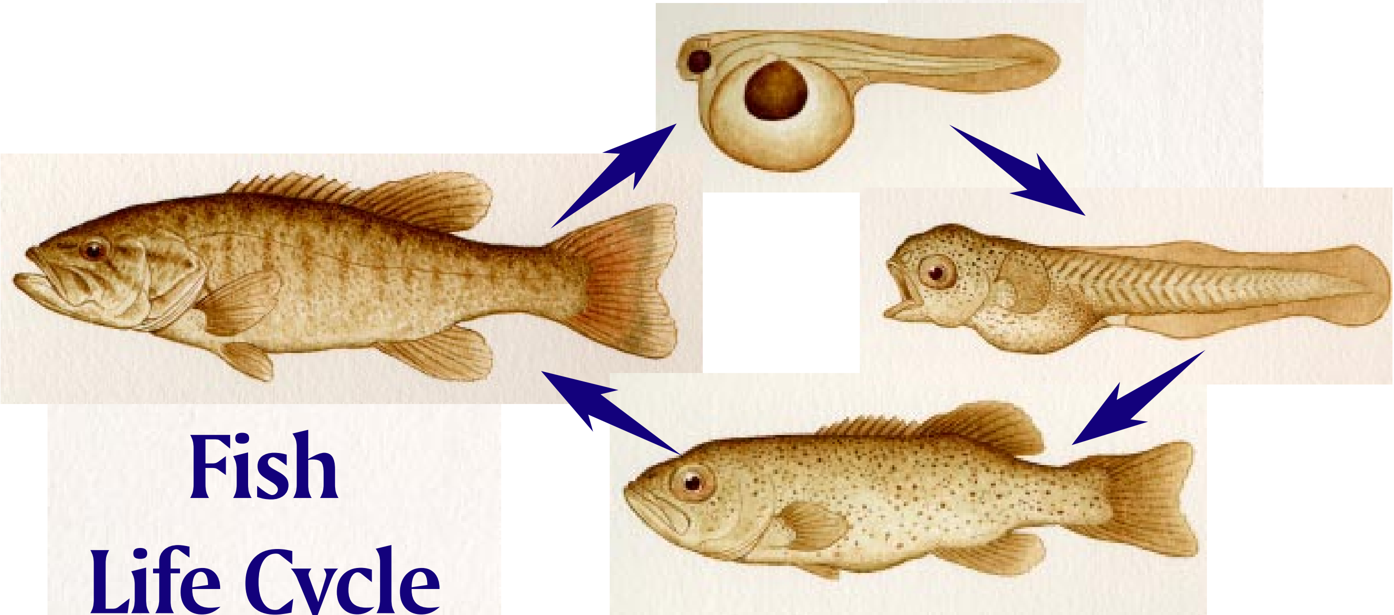
COMMON NAME	SCIENTIFIC NAME
1. Bullfrog	*Rana catesbeiana*
2. Stonefly	*Acroneuria*
3. Sycamore	*Platanus occidentalis*
4. Dobsonfly	*Corydalus cornutus*
5. Caddisfly	*limnephilus*
6. Silver Maple	*Acer saccharinum*
7. Wood duck	*Aix sponsa*
8. Mayfly	*Rhithrogena*
9. Whitetail Dragonfly	*Plathemis lydia*
10. Great blue heron	*Ardea herodias*
11. Midland water snake	*Nerodia sipedon pleuraliss*
12. Belted kingfisher	*Megaceryle alcyon*
13. Water willow	*Decadon*
14. Snapping turtle	*Chelydra serpentina*
15. Leech	*Placobdella parasitica*
16. Longnose gar	*Lepisosteus osseus*
17. Striped shiner	*Luxilus chrysocephalus*
18. Channel catfish	*Ictalurus punctatus*
19. Smallmouth bass	*Micropterus dolomieui*
20. Dragonfly nymph	*Plathemis lydia*
21. Creek chub	*Semotilus atromaculatus*
22. Red-eared slider	*Pseudemus scripta*
23. Flathead catfish	*Pylodictus olivaris*
24. Freshwater drum	*Aplodinotus grunniens*
25. Golden redhorse	Moxostoma erythrurum
26. Threeridge mussel	*Amblema plicata plicata*
27. Snail	*Aplexa*
28. Stonefly nymph	*Acroneuria*
29. Hellgrammite (dobsonfly)	*Corydalus cornutus*
30. Mayfly nymph	*Rhithrogena*
31. Pink heelsplitter mussel	*Potomilus alatus*
32. Logperch	*Percina caprodes*
33. Fingernail clam (open)	*Sphaerium*
34. Northern hog sucker	*Hypentelium nigricans*
35. Stonecat	*Noturus flavus*
36. Stoneroller	*Campostoma anomalum*
37. Largemouth bass	*Micropterus salmoides*
38. Longear sunfish	*Lepomis megalotis*
39. Water penny	*Psephenus herricki*
40. Rainbow darter	*Etheostoma caeruleum*
41. Banded sculpin	*Cottus carolinae*
42. Cladaphora (algae)	*Cladaphora*
43. Limpet	*Gundlachia*
44. Crayfish	*Cambarus*
45. Rock bass	*Ambloplites rupestris*
46. Snuffbox mussel	*Epioblasma triquetra*
47. Bluntnose minnow	*Pimepales notatus*
48. Caddisfly larva	*Limnephilus*

Bullfrog Life Cycle

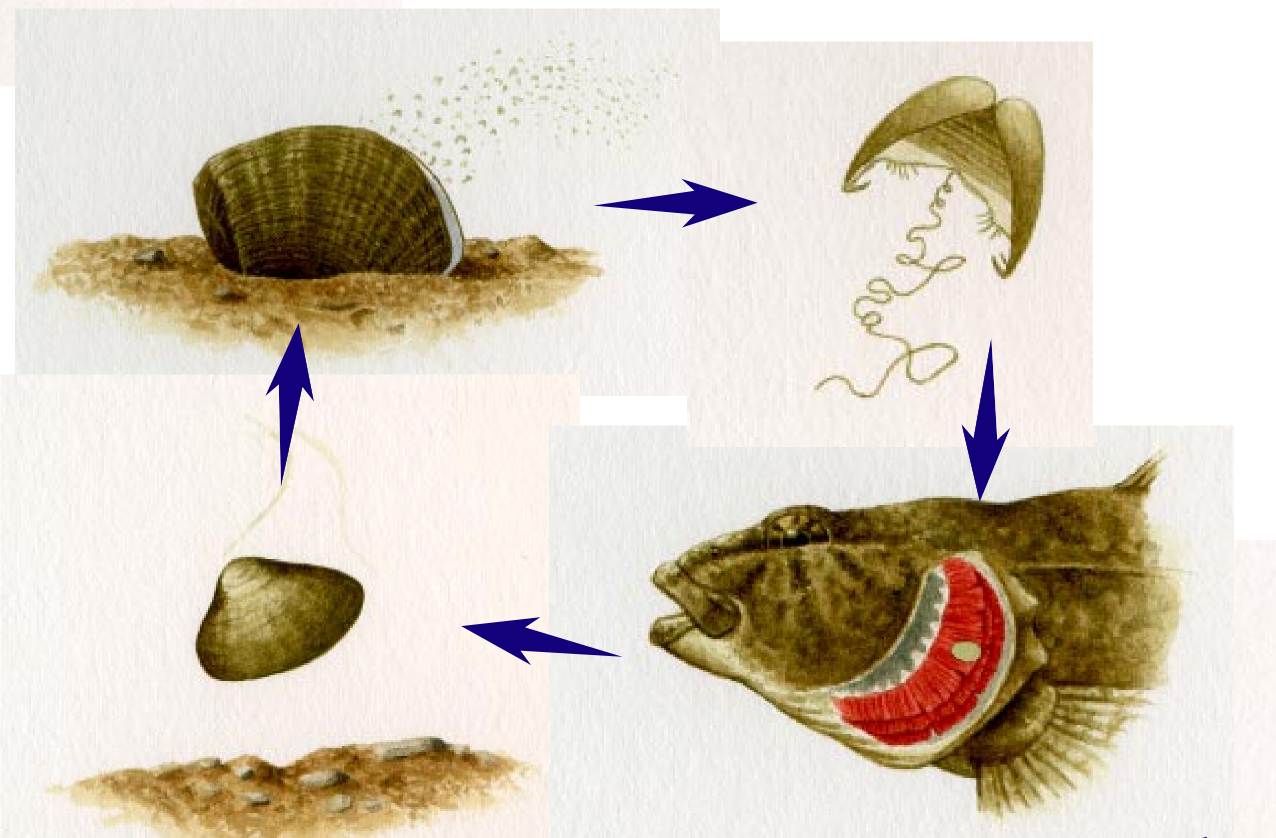


Dragonfly Life Cycle





Fish Life Cycle



Mussel Life Cycle

ALL MY LIFE'S A CYCLE

Sung to the tune of "All My Life's a Circle".

All my life's a cycle.
    tadpole to a frog.
I swim around and use my gills
    then I sit upon a log.

All my life's a cycle
    and then I lay my eggs,
unless the heron comes along and
    eats me nose to legs!

(Perhaps your students will have more verses
after completing their poster study.)

Notes

Life is a cycle for most of the animals that live in an aquatic environment such as a stream or river. For the frog, insect and mussel, that cycle includes metamorphosis or a physical change of body form within a single individual's life. Others such as fish, turtles, some snakes and birds are hatched from eggs as young which resemble the adult animal. Mammals are born alive (as are most water snakes and a few fish) with the same body form as the adult parents.

Metamorphosis is one of the most complex and interesting occurrences in nature. While frogs are normally mentioned because of student recognition of both tadpoles and adult frogs, salamander (not shown), insect and mussel transformations are equally fascinating. Length of life for adult frogs is different for each species but is much longer than the respective tadpole stage. In comparison, adult insects lifespan may be measured in hours, while the larval stage may last for several years. Mussel larvae (or glocidia) attach to fish gills where they ride as a parasite for a few weeks. Once the developing mussel falls off the fish, it remains within a few meters of that spot for the rest of its life, which can last for decades.

Interrelationships of species is an equally exciting aspect of the aquatic ecosystem. The four species depicted in life cycles are all interrelated at different times. Larval fish, tadpoles, some larval insects and adult mussels eat similar food items (plankton). Larval stages of insects, tadpoles and young fish are all potential prey for adult fish. However, certain larval insects such as dragonfly nymphs and hellgrammites are also predators and will eat larval fish along with other insect larva. Other relationships include adult frogs eating adult insects and as previously mentioned, the mussel larvae relying on fish for a ride to establish a new mussel bed.

Just as the animals change through their life, the ecosystem is changing. Even in natural systems, floods or glaciers have dramatically changed the landscape. The lifetime of a river is measured in millions of years, and as changes occur, the species found within that system change also. When rivers of ancient Kentucky were altered or isolated by the glaciers, the aquatic bound species could no longer mix with their own species in other systems. In the 15,000+ years that have followed, the physically separated species have become separate species. This is the natural process of speciation due to isolation.

SUGGESTED ACTIVITIES:

Primary students (Grades K-3) - From Project WILD Aquatic, “Are You Me”**,** pages 14 to 19. In addition to matching adults to young, have students identify which animals have changed their form.

Students (grades 4-5) - Have students draw or trace selected animals from the poster. If the four depicted species are not used, have them draw their perception of the larval stage or young of the year for the selected species. Show how the different species are interrelated by drawing lines from one to another. On the line indicate if one eats the other, competes for food at a given stage or has some other relationship.

Students (grades 6-8) - Using the stream or river system in your locality, have the students simulate a massive change to the ecosystem.

- Using a topographical map (available from Natural Resources Conservation Service offices), indicate where the river might change course during the “500 year flood”.

- Suppose a volcano erupted within a given river drainage and created a massive dam. What organisms might be lost due to their requirement for flowing water? Would volcanic activity alter temperatures to change the aquatic life as it is currently known? What minerals might be released to increase aquatic plant life? What river ecosystem is nearby which might receive the eventual runoff as the new lake fills and overflows?

For information on volcanic effects on aquatic ecosystems, students can research volcanic action on Iceland, Mount St. Helens and Yellowstone National Park.

Students (grades 9-12) - Suppose rabbits had evolved with metamorphosis (including some phase in an aquatic environment) as part of their life cycle. Have students create (artistically or in written form) the habitats and metamorphic forms which would precede the adult rabbit. They could include as many stages as students visualize.

- Where would the eggs develop and what environment would they need to mature?

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- If eggs were fertilized externally, how many embryos would be needed to ensure survival of two individuals to adulthood (parental replacement)?

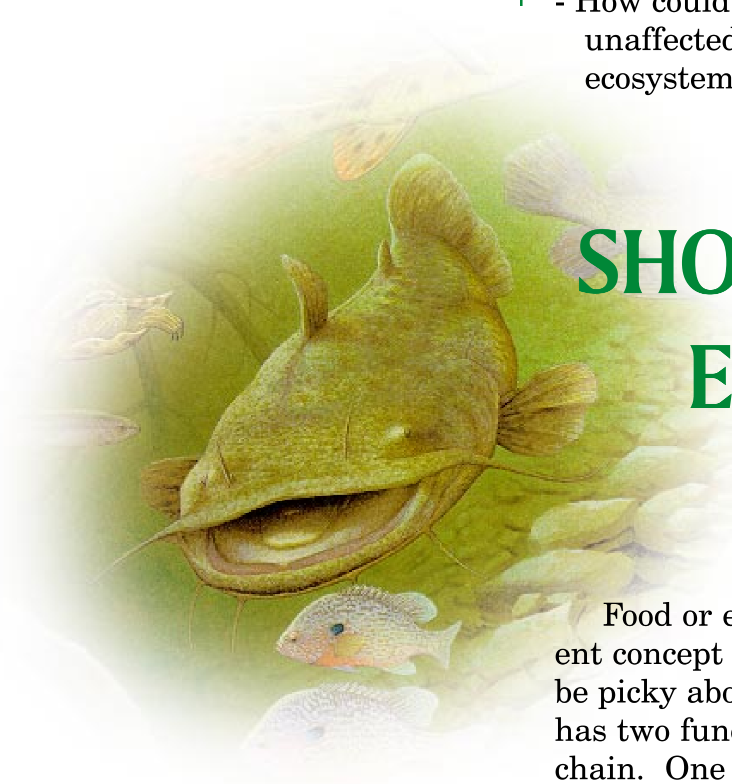
- What would the larval stage look like, what habitat would it require and what relationships would it have with other animals in that habitat?

- At what age would metamorphosis take place into the adult form? How is this related to ecosystem stability and endangerment?

- Which metamorphic stage would be safest in an aquatic environment?

- How long would adults live? Would they have one chance for reproduction or live multiple years as a reproducing adult?

- How could you design metamorphosis of rabbits to be unaffected by chaos in nature, the natural fluctuation in ecosystems?



SHORT vs LONG TERM EFFECTS OF THE FOOD CHAIN

Food or energy in the natural world is a totally different concept than in a student's life. While the student can be picky about what and when to eat, each animal depicted has two functions in their life which pertains to the food chain. One is to find something to eat which provides maximum energy gain; the other is to avoid being someone else's dinner. With that in mind, the feeding location an animal chooses is important. An ideal location would provide food which would require very little energy expended for each bite. To satisfy the "not being eaten" function, having a feeding location which provides hiding opportunities is essential.

Every life maintenance function requires energy including chasing, catching and processing food. Therefore, the energy "bank account" must equal energy gained and used. When excess energy is available, it is used for growth and reproduction. When energy sources are marginal, the first instinct is individual survival. Individuals who don't find sufficient food may not have the energy available for reproduction. Their energy is expended for maintenance only and growth is very slow.

Plants near the water contribute leaves, seeds and woody debris to the ecosystem. These are important food sources plus the debris provides shelter for hiding. Rooted vegetation in a stream, while not abundant in the poster, is a food source for plant eaters and shelter for prey species.

In addition to energy, certain nutrients such as minerals are required by each individual. These nutrients have been passed through the food chain and recycled since the earth first began to support life. The release of minerals from the earth can be accomplished by glaciation, volcanic eruption or fresh water springs from limestone. Resources which are near any of these conditions produce excellent growth potential for aquatic systems. However, organisms which aid the decaying process are extremely important to the process as they ensure these valuable assets are not tied up in dead material. Examples of depicted organisms which are in a state of decay include mussel shells, a crayfish claw and the spine of a carp.

Adaptability to available food items is a valuable trait within a species. Every year brings varying natural conditions (flood or drought) which favor one or another plant or animal species. Human influences can also alter the food chain as certain species may be more or less tolerant for the conditions created in an altered ecosystem. Animals which are best suited to adapt to the available food will have a much better chance of survival, growth and reproduction. Gar are an excellent example among fish. In contrast, mussels are filter feeders which are essentially immobile as adults. Altering the stream with reservoirs or introducing excessive silt can eliminate habitat and reduce the mussel population over time.

All this discussion is related to survival of the fittest. That individual which has the best feeding location will grow fastest and have the most excess energy and nutri-

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ents for reproduction. Offspring from that individual will then be more numerous, and the genetic material which established dominance to compete for the feeding location will be passed on.

LINKS IN THE CHAIN

CHAIN LINK # 1 - The sun's energy is transformed into usable forms through photosynthesis in plants.

CHAIN LINK # 2 - Plant eaters use their food in various forms. Some eat living plants (grazers), others process large parts that fall into the water, such as leaves or seeds, (shredders) and still others filter tiny plant particles, living or dead, from the water (filter feeders).

CHAIN LINK # 3 - This link could represent predators, scavengers, decomposers or omnivores. Any of these can be placed in this link, as

CHAIN LINK # 4, the top line predator serves as predator of several animals beneath it in the chain. For instance, adult smallmouth bass may serve as predators for plant eaters (crayfish or insects), predator insects (larva or adult) or any small fish in the stream.

SUGGESTED ACTIVITIES:

First Natural Bank of Energy (adapt to grade level). Compare student energy requirements with the stream animals depicted. How do different animals make "deposits and withdrawals" in their individual energy accounts. Using a human calorie chart as an example, have students design a representative chart for a selected animal with different food items giving different energy inputs. How many units of energy must individual have "in the bank" when fall turns to winter after 200 days of feeding? Excess in the spring goes to growth and reproduction.

Students should research food habits for different species to determine what should be included in their chart.

EXAMPLE:

SPECIES	DAILY REQ. FOR MAINTENANCE (X 365 FOR ANNUAL)	
Longnose gar	200 units x 365 = 73,000 units.	
FOOD ITEMS	**AVERAGE UNITS PER INDIVIDUAL EATEN.**	
Bluntnose minnow	8 units x 10 per day	= 80 units
Creek chub	20 units x 4 per day	= 80 "
Longear sunfish	50 units x 4 per day	= 200 "
Smallmouth bass (young)	20 units x 3 per day	= 60 "
	DAILY TOTAL = 420 "	
	200 feeding days = 84,000 units	

Excess for growth and reproduction is 11,000 units. If reproduction requires 8,000 units, 3000 units are dedicated to growth. NOTE: The next year more energy would be required for maintenance as the fish is now larger. Therefore, more food will be required.

All numbers are arbitrarily assigned for this exercise only. Users may desire to expand this list with additional species for the “Energy Bank”.

SPECIES	ENERGY SOURCE/ AMOUNT NEEDED(ANNUAL)	ENERGY PROVIDED WHEN EATEN
Longnose gar	Other fish/73,000 units	500 units
Smallmouth bass (4 inch)	Insects, larval fish/500 units	20 units
Smallmouth bass (12 inch)	Crayfish, fish,insects/1200 units	100 units
Crayfish	Plants, dead material/400 units	50 units
Dragonfly nymph	Larval insects or fish/150 units	10 units
Longear sunfish	Larval insects/300 units	50 units
Hellgrammite	Larval insects/20 units	10 units
Rainbow darter	Larval insects/200 units	10 units
Bluntnose minnow	Algae, small insects/200 units	8 units
Striped shiner	Plankton, small insects/200 units	8 units
Creek chub	Plankton, larval insects/400 units	20 units
Stonefly nymph	Plants/15 units	4 units
Mayfly nymph	Plants/15 units	4 units
Logperch	Larval insects/250 units	12 units

Notes

Primary Students (K-3). Using the poster, find depicted plants or plant material. Next, find insect larvae, crayfish and mussels (plant eaters). Find fish which are eating or ready to eat other creatures. Which fish might eat each other?

Students (grades 4-5). From Aquatic Project WILD, "Watershed", pages 172 to 175 is recommended. Have students study a watershed near their school and compare it to the poster. What is happening in the neighborhood watershed to alter food chains in the water?

Students (grades 6-8). From Aquatic Project WILD, "Riparian Retreat", pages 34 to 37 is recommended. Compare local waterways to the poster and description in the exercise. What is the state of the riparian zone in your town? How does streamside vegetation affect food chains?

Students (grades 9-12). From Aquatic Project WILD, "Water Canaries", pages 38 to 41 is recommended. Have students sample aquatic life and determine "waterway health" (including food chains) based on their findings. What could be done to improve the stream?

EXTENSIONS: All students could be encouraged to research pollution factors such as siltation, pesticides or industrial discharge to find individual and cumulative effects upon the food chain.

ECOSYSTEM & LANDSCAPE BIODIVERSITY

This poster was designed to emphasize primary animals within a stream ecosystem. Those selected would indicate a healthy waterway. It may be noted that microscopic life and mammals are not represented. That in no way implies unimportance, as each species is equally important in the ecosystem concept. Space on the poster would not allow all species to be shown.

Notes

When you put a puzzle together and find one or more pieces missing, an incomplete picture results and a degree of frustration exists for the puzzle workers. The same is true with this poster. When any species or genetic strain is lost, the picture is incomplete. Choose any species on the poster and cover it. Have students discuss what might happen to other species if in fact the covered one were eliminated. Not only is the picture not as pretty, some species may decline and others may have advantages with that species missing.

Each facet of the stream ecosystem is important. One important section is streamside (riparian) vegetation. Trees at the stream's edge provide shade to cool the water, roots to hold the soil and leaves or seeds which fall in the water to become food for certain organisms. Further, terrestrial insects which feed in the trees fall into the water to become part of the food chain. Trees also serve as perches for birds such as kingfishers. When snags are left, woodpeckers search for insects in the dead wood, and later wood ducks nest in the woodpecker holes.

While a great deal of time and energy has rightfully been devoted to endangered species, current focus is on ecosystems, including a combination of ecosystems or landscape biodiversity. Studying the effects of human activity in aquatic or terrestrial ecosystems up or down stream allows "puzzle analysis" in a holistic view of rivers. The depicted stream is forever connected to other similar streams or major rivers and each has related forests, fields or urban area. If the depicted scene is to remain healthy, all ecosystems within the landscape must also be maintained.

The single pollutant which most greatly affects flowing rivers and streams remains siltation from agriculture and urban development. Other human activities which physically alter stream habitat include reservoir construction, lock and dam structures and channelization.

The guild of animals which suffers most from human intervention are referred to as "benthic organisms", those dependent for some portion (or all) of their lives on stream bottom habitat. This could mean any fish which hides, feeds or builds a nest on the bottom. Groups of benthic fish (several species each) such as madtoms, darters and dace are known to be declining.

Notes

While benthic fish and insects have been identified as having problems, perhaps the most threatened benthic group is mussels. Their situation is complicated by a variety of conditions.

- Many populations of mussels have shown little or no known re- production since major reservoirs were placed on certain rivers.

- These structures change water flow rates and temperature. Temperature stimulates reproductive activity of aquatic animals and little is known on specific requirements of mussels. However, with continuous cold water discharged from the reservoir, the water may never reach the appropriate temperature for reproduction.

- Reservoirs also prevent fish (which provide transportation for larval mussels) from migrating in the natural flowing river.

- Major rivers in Kentucky have lock and dam structures which alter flow rates and sedimentation patterns.

- Streams and rivers have been dredged and channelized. Dredging directly removes mussels and channelization alters flow rates and fish populations.

- Siltation affects mussels and fish populations which are potential hosts for glocidia.

- Industrial and pesticide pollution accumulate in mussels as they are filter feeders. Direct results are unknown at this time due to lack of research. These effects in other species have decreased reproductive ability.

- The zebra mussel, an exotic species, have been found completely covering native mussels and preventing filtering behavior.

SUGGESTED ACTIVITIES:

The discussion of biodiversity is a complex issue. It may be best suited for later middle and high school grades. Discussion at lower levels would be best aimed at how the system is destabilized by the loss of certain animals, then restabilizes as an altered system (chaos in nature). Younger students might compare this to friends who moved away and how this changed the class.

Students, (grades 4 - 12) - From Aquatic Project WILD, "To Dam or Not To Dam", pages 134 to 137. Place emphasis on the effects a reservoir on the river in your town would have on the animals that live there. How would it alter species and ecosystem biodiversity?

Students, (grades 7 - 8) - From Aquatic Project WILD, "Watered Down History", pages 116 to 119. Using contacts with elderly residents, have students research how the local waterways have changed, when this happened and what was the causative factor.

Students, (grades 9 - 12) - The fallen branch or log in the poster is a singular "ecosystem" within the "stream ecosystem". The fourth component of biodiversity, landscape diversity, is important in the overall scheme of nature, as the represented stream is fed by smaller streams and feeds into larger rivers.

- Have students illustrate the relationships of plants and animals from both up and down stream to the plants and animals in this poster.

- Have students research selected species.

- Which are tolerant or intolerant to change.

- Is there an indicator species present?

- Is there a keystone species present?

- After research, have students write a paper on where the greatest (or least) aquatic biodiversity exists today and why. Is this different from pre-settlement? Is it changing today, and if so, why?

Notes

GLOSSARY

** indicates quoted definitions from Project WILD.*

Benthic - A term which describes the bottom environment of an aquatic ecosystem.

BIODIVERSITY -

Species diversity - The number of species found. Normally when more species are present, ecological systems are more stable based on interactions between species.

Genetic diversity - Each species needs variety within its gene pool to provide protection against catastrophic loss due to disease or mutation.

Ecosystem diversity - Within each ecosystem there must be diversity of habitat features to provide the needs for the species present.

Landscape diversity - Wide area diversity as demonstrated by a watershed or mountain range. Each ecosystem within the landscape is dependent upon the health of other aquatic and terrestrial systems. Many species within individual ecosystems often travel to other systems for certain life requirements.

Ecosystem - Dynamic and interrelating complex of living organism communities and their associated non-living environment.

Glocidium - The larval stage of a mussel. (Plural glocidia)

Guild - A group of animals which inhabits the same general area. For instance, all animals whose habitat requirements are met in a stream riffle would belong to one guild.

Indicator species - A species which is particularly intolerant to a given situation. Hellgrammites are intolerant of pollution, therefore their presence indicates an unpolluted system.

Keystone species - A species which causes a collapse of the ecological system with its absence. Comes from the theory that a building has a "key stone" without which the building will collapse.

Lifespan - The period of time an animal spends alive.

Metamorphosis A natural process where an animal changes form during its life cycle. Usually indicates a different manner of attaining oxygen and living in a different environment.

Nutrients - Those components of the earth, both organic and inorganic, which are used by plants for growth. Passed to animals for temporary functions (carbon in sugar) or to be incorporated into long term structure such as bone (calcium). Nutrients are returned to the earth for further growth by the decaying process and through natural elimination cycles.

***Omnivore** - "An animal that eats both plant and animal material."

***Parasite** - "An organism that lives by deriving benefit from another organism, usually doing harm to the organism from which it derives benefit."

***Predator** - "An animal that kills and eats other animals."

***Prey** - "Animals that are killed and eaten by other animals."

Reservoirs - Impounded water behind a human-made dam. Lakes are created naturally, humans create reservoirs.

Riparian - A term used to describe the vegetation which is associated with river or creek bottoms. Generally those plants in the floodplain which receive the majority of their water either above or below ground from the waterway.

***Scavenger** - "An organism that habitually feeds on refuse or carrion."

Siltation - The process by which soil particles are deposited on the bottom of aquatic systems.

Speciation - A natural occurrence where one species gives rise to two different species.

Topographical maps - Maps which show terrain features.

Watershed - That land area which is drained by a given waterway.

SPORT FISH RESTORATION

Federal Aid Project
funded by your purchase
of fishing equipment
and motor boat fuels