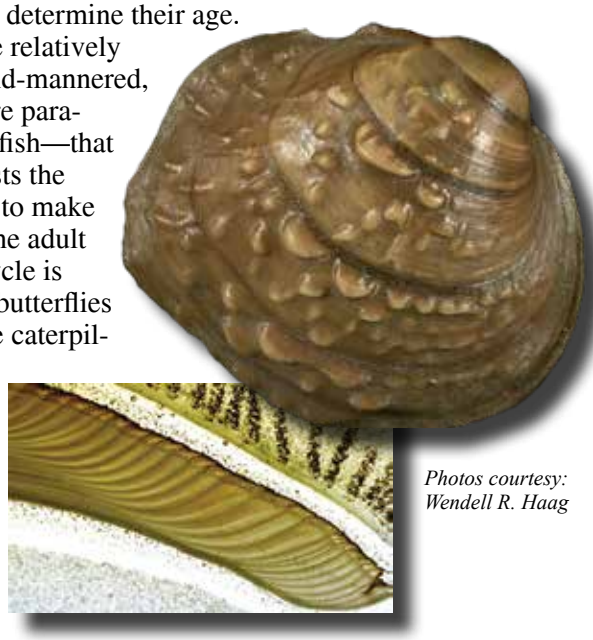
The Hidden and Imperiled Gems of Kentucky's Rivers

by Wendell R. Haag

Kentucky is well known for its diversity of plants and animals. The forests of Eastern Kentucky and streams throughout the state are some of the most biologically diverse compared to other temperate regions of the world. Another aspect of Kentucky's biodiversity, which is even more remarkable from a global perspective, is unknown to many people. Kentucky, along with Alabama, Georgia, and Tennessee, is home to the richest freshwater mussel fauna, not just in temperate regions, but anywhere on Earth. Each of these states has over 100 native mussel species, which exceeds by far even tropical areas such as the Amazon, Congo, and Mekong river basins. Several of Kentucky's rivers are home to more than 40 mussel species, and in some places, one can find more species in one square foot of river bottom than occur on the entire continent of Europe. This diversity is not widely known because mussels spend most of their lives out of sight, buried in the gravel or sand. Consequently, many people think mussels and other bivalves live only in the ocean, and they are surprised to find the beautiful shells of freshwater species on river bars or shorelines right here in the Commonwealth.

Mussels have a fascinating life cycle. Some mussel species live only a few years, but many live decades and a few can live well past 100 years, making them among the longest-lived animals on Earth. Mussels produce annual rings in their shells–similar to tree rings–that can be counted to determine their age. Adult mussels are relatively sedentary and mild-mannered, but their larvae are parasites—usually of fish—that get from their hosts the energy necessary to make the transition to the adult stage. This life cycle is similar to that of butterflies and moths, whose caterpillar larvae must feed on plants in order to emerge as an adult. Like butterflies, most mussel species are specialists whose larvae can use only certain types of hosts. Some mussels use only bass, some use minnows, others use only



Photos courtesy: Wendell R. Haag

Mussel shell age rings. Like tree rings, mussels produce a conspicuous ring in their shell each year, which is associated with a slowing of growth in the winter. These rings are visible on the exterior of the shell in many cases (top), but they are interrupted more accurately and consistently by examining thin sections of the shell under a microscope (bottom).

Mussels have beautiful shells, which come in a wide variety of shapes, sizes, and colors.

Photo courtesy: Monte McGregor

catfish, and so on; one mussel species is a specialist on the mudpuppy, a large, aquatic salamander.

The most unusual aspect of this life cycle is the array of strategies by which mussels ensure their larvae find the appropriate type of host. Mussels whose larvae require bass as a host display large lures that mimic bass prey such as minnows or crayfish. When a bass tries to attack these lures, they receive a mouthful of mussel larvae instead of a meal. Similarly, mussels that use fish that feed on insects—fish such as darters and minnows—release their larvae in small packets that mimic insect larvae or other prey items to an astonishing degree. Mussel larvae remain on the host usually for a few weeks after which they drop off and fall to the bottom wherever the fish has carried them. This dispersal on fishes is important in allowing mussels to colonize new habitats. For the fish's part, mussel larvae usually are only a minor annoyance–like ticks or lice–and the fish is usually unharmed by the experience.

Mussel lures. Mussels use astonishing mimicry to ensure that their parasitic larvae encounter a suitable host. The wavy-rayed lampmussel (top) displays a lure resembling a small fish, which attracts bass (second), the larval host for the species. The fluted kidneyshell releases its larvae in small packets that closely mimic blackfly pupae (third), a major food item for their darter hosts. Similarly, the fanshell releases its larvae in packets that resemble small worms (bottom).

Photos courtesy: Chris Barnhart (all photos except second), and Wendell R. Haag (second).

Mussels are important for reasons other than their diversity, beauty, and interesting life cycle. Like most bivalves, freshwater mussels are filter feeders that eat algae and other material suspended in the water. This filtered material is deposited in the stream bottom where it is broken down further by other organisms. Mussels filter nearly around the clock, and in streams with large populations, the combined filter feeding of thousands of mussels can improve water quality tremendously, which benefits fish and other aquatic organisms as well as people who use the water. This service is provided free of charge with no maintenance costs. Mussels also are important as a food source for a wide array of animals including many fish species, turtles, and mammals such as muskrats and otters.

Sadly, this vital filtering service and unique part of our natural heritage is disappearing rapidly. In the last 100 years, over 30 North American species have become extinct, including at least 12 species native to Kentucky. Most of these species were driven to extinction by dams, which transformed the shallow, free-flowing habitats on which these species depended into deep, still reservoirs. For example, construction of Wolf Creek Dam in 1950, which transformed the Cumberland River into Lake Cumberland, directly contributed to the extinction of at least three mussel species and left several other species critically endangered.

The era of large dam construction came to a close in the 1970s, but mussel populations in remaining free-flowing streams nationwide continue to decline rapidly. In Kentucky since the 1970s, mussels have disappeared almost completely from many streams, and dozens of species either have disappeared from the state or now teeter on the verge of extinction. In some cases, mussels appear to have been eliminated by severe water pollution from coal mining, oil and gas extraction, or other sources. But mussels have disappeared even from many streams that lack obvious sources of pollution. These enigmatic declines are particularly worrisome because, without knowledge of their causes, we have no way to protect other streams from similar declines or to restore affected streams.

Research Is Under Way

A main focus of my job as a fisheries biologist is to study how land management practices affect the health of aquatic ecosystems. This summer, I am conducting a study that will attempt to identify specific causes of enigmatic mussel declines. This study is a collaborative effort between the U.S. Forest Service, the Kentucky Division of Water, and the Kentucky Department of Fish and Wildlife Resources' Center for Mollusk Conservation [see sidebar on page 18].

Beginning last November, the Center for Mollusk Conservation raised several thousand juvenile mussels by artificially infecting largemouth bass with larvae of the pocketbook mussel. In May, when these mussels were about six months old, we placed them in 24 streams across Kentucky, from Trigg County in the west to Greenup County in the east, and from Pendleton County south to the Tennessee border. These streams represent a range of conditions, from streams in which mussels have declined or disappeared to those that still support healthy populations.

In each river, we placed the mussels in two types of enclosures so we could relocate them at the end of the summer. One type, called a silo, primarily exposes mussels to the stream water, but we also placed

Juvenile mussels. *Photo courtesy: Monte McGregor*

All photos this page courtesy: Monte McGregor

Mussel silos and cages. For experimental purposes, juvenile mussels (page 17) are held in streams in concrete silos (top), through which flows a steady current, ensuring that mussels have adequate oxygen and food. Mussels also are held in small plastic cages that are buried in the stream bottom (bottom).

mussels in small cages buried in the river bottom, which provides exposure to stream sediments. We used these two types of enclosures because some types of contaminants are more prevalent in the water while others are more prevalent in sediments.

At the end of the summer, we will retrieve the enclosures and record mussel survival and growth.

Simultaneous with the experiment, the Kentucky Division of Water is conducting detailed measurements of water and sediment quality in each river as part of their statewide Ambient Water Quality monitoring program. If we find differences in mussel survival or growth among sites, we hope to be able to relate these differences to the presence of specific contaminants or other water or sediment quality factors. It is possible that whatever factors were responsible for mussel declines are no longer present in streams. For example, DDT or other older pesticides may have negatively affected mussels—similar to their effects on birds and other organisms—but because these chemicals are no longer used, conditions may have improved such that these streams once again are capable of supporting mussels. If so, we should see high mussel survival even in these previously affected streams, meaning that those streams may be candidates for restoration and restocking with mussels raised by the Center for Mollusk Conservation.

Regardless of the outcome, our experiment should provide valuable information needed to conserve the extraordinary mussel fauna of Kentucky and North America in general. Stream ecosystems that have lost their mussels and the vital services they provide are severely compromised, and their ability to support a wide range of uses is diminished. Together with information from our experiment and other research efforts occurring across the country, we hope one day to restore the full function of stream ecosystems, which will provide immeasurable benefits to all people.

The Center for Mollusk Conservation

The Center for Mollusk Conservation (CMC) was founded in 2002 by the Kentucky Department of Fish and Wildlife Resources in Frankfort, KY. The mission of the CMC is to

restore and recover rare and imperiled mussels in Kentucky. Dr. Monte McGregor, director of the CMC, and his staff, have refined, and in some cases perfected, many methods for the culture and propagation of freshwater mussels in a hatchery environment. For example, CMC staff have developed the ability to culture large quantities of

algae and other mussel food sources, which is critical for optimal mussel survival and growth. The CMC also has pioneered methods for raising mussels in artificial culture media and thus bypassing the requirement of the parasitic phase on host fishes. These and other advances allow production of large numbers of healthy mussels, which can be used to restock depleted streams. The production capacity of the CMC is an integral part of efforts to restore the mussel fauna of Kentucky and beyond.

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