LIVING WITH MUSSELS

Local governments can protect endangered mussels, enjoy high quality water and make sure that road and construction projects stay on schedule.

"Mussel blocks way of Monroe bypass"
–Charlotte Observer, Sept. 18, 2002

"Rare mussel delays construction"
–The News and Observer, Sept. 19, 2002

The state's largest newspapers played the same tune two years ago to explain why construction on the U.S. 74 Bypass near Monroe had stopped: It was the mussel's fault, they agreed.

The mussel in question was the Carolina heelsplitter (*Lasmigona decorata*), a 4 1/2-inch-long freshwater mussel that is the most endangered of all of North Carolina's endangered mussels. No more than 100 individuals remain in six populations in North and South Carolina. The U.S. 74 Bypass, aka the Monroe Connector, would slash the commuting time to Charlotte and ease beach traffic, but its secondary and cumulative impacts on Goose Creek, the heelsplitter's habitat, could further threaten the mussel. So the project was stalled while wildlife biologists and local government officials wrangled over how much protection to offer the beleaguered mollusk.

It was a David-and-Goliath story, except the tiny heelsplitter had the villain's role. And it was not the only time a freshwater mussel has played the heavy. Since 1999, 109 road projects were delayed in the state while local ordinances, stormwater controls and other measures were put into place to safeguard federally protected freshwater mussels. In coming years, more roadway projects are planned near waters containing endangered mussels and other aquatic species.

Such controversy has created the impression that protection of aquatic ecosystems requires throwing a monkey wrench into plans for growth and development. Yet some local governments are learning how to protect their watersheds, freshwater mussels and economic growth, all at the same time. Smart planning can direct growth where it will do the least harm to a community's natural resources. And when it comes to aquatic ecosystems, we're talking about some of the most sensitive and threatened natural resources in the state.

Written by Lawrence S. Earley

Illustrated by David Terry / Photographed by Jody Duggins

An Alien World

To understand the issues surrounding freshwater mussels, I began my quest at an unusual facility: the Mussel Barn on the campus of the College of Veterinary Medicine at NCSU. It's one of the few places in the country where the life cycle of the mussel — one of the most fascinating progressions in the natural world — is being duplicated under laboratory conditions. In the Mussel Barn, I could gain an understanding of why mussels rely on a healthy aquatic ecosystem.

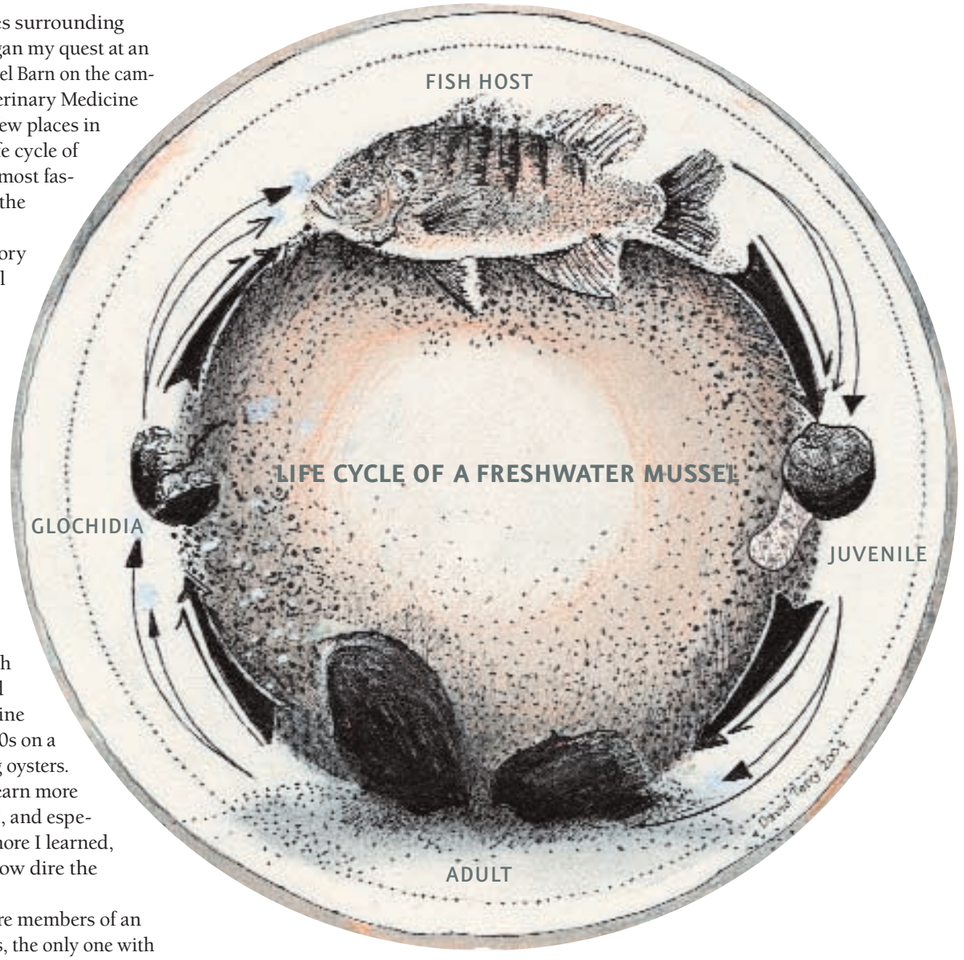
"The barn used to be the center of research for oysters back in the 1980s," said Jay Levine, associate professor of epidemiology in the College of Veterinary Medicine, as we toured the lab. It was crowded with tanks and noisy with running water. "I worked with the Division of Marine Fisheries back in the 1980s on a pathogen that was killing oysters. That's when I began to learn more about bivalves in general, and especially mussels, and the more I learned, the more I discovered how dire the situation was."

Freshwater mussels are members of an unusual group of bivalves, the only one with a parasitic larval stage. Basically, mussels need a fish host to complete their metamorphosis from larval stage to juvenile stage. When the female mussel is ready to release her young, she dresses them up in a tasty-looking package that mimics a tiny minnow. When a fish approaches, the microscopic mussel larvae, called glochidia, are expelled from the mother and attach to the fish's gills, where they remain for a few weeks, feeding and growing larger before dropping to the stream bottom. Some mussels are totally dependent upon a specific species of fish host.

To study the mussel life cycle, Levine brings gravid, or pregnant, female mussels into the lab and harvests the glochidia from the mussel using a pipette. "Then we put the larvae in a bucket of water with a fish, and they immediately attach to the fish's gills," he said. "When the juveniles fall to the bottom of the tank, we vacuum them up and bring them over here."

He pointed to a series of halved PVC pipes that contained layers of sediments of various sizes. As the juveniles grow, they are moved from a pipe containing coarse sediments to progressively finer sediments so they can be seen more easily. "From here, they go to that trough over there that simulates a natural stream, where they can grow larger."

By his accounting, Levine is the only research veterinarian in the country who works with mussels. His interest stems from a larger concern with environmental health. Mussels are filter feeders, straining zooplankton as well as algae, bacteria and other harmful substances from the water and cleaning it in the process.



Fish are entwined in the life cycles of most freshwater mussel species. After an adult female mussel emits a cloud of larvae called glochidia, the larvae find a host fish and attach themselves to its gills. After several weeks of growth, the young mussels fall from the gills and nestle into the stream bottom. They develop into mature mussels in six to eight years.

Mussels are part of an intricate web of aquatic life that links an astonishing diversity of life forms including fish, crayfish, snails, turtles and amphibians, and the aquatic larvae of mayflies, caddisflies and stoneflies. The aquatic ecosystem includes birds such as kingfishers and herons, osprey and waterfowl, and terrestrial species such as raccoons, beaver, mink, otter and others. Some of these animals eat only plants, others are carnivores, and still other species will eat just about anything. They depend on each other, and they depend on the quality of the water in which they live.

"Mussels are an indicator species, and if there's something that's preventing them from living, it indicates a system out of balance," said Levine. "And that affects us." The absence or decline of mussels in freshwater streams is an indication that something is wrong.

And, indeed, something is wrong. Freshwater mussels are among the most endangered animals on Earth. About 70 percent of the mussel species in the United States are listed as endangered, threatened or of special concern. In North Carolina, more than half the state's 60-some species of freshwater mussels are on federal or state protected-status lists. Nine mussel species known to have existed in the state are gone today.

Mussels aren't the only aquatic species in trouble. One-quarter of the state's 200 species of freshwater fish are listed as endangered, threatened or of special concern, and many crayfish species are in similar straits. Aquatic ecosystems, dependent on many delicate processes such as the remarkable life cycle of the freshwater mussel, are in serious jeopardy today.

Yet, it's difficult for most people to feel sympathy for creatures from a world they don't see. "Aquatic ecosystems are like alien worlds to most of us," Levine said.

Mussels may use various lures to attract host fish. The lips of this newly discovered *Lampsillus* species (middle) resemble a tasty minnow as they ripple in the current in a Granville County streambed. To better understand the mussel life cycle, biologist Jay Levine raises mussels at NCSU's Mussel Barn for close study (top and bottom).

A Flood of Mud

Mark Fowlkes ducked beneath a low-hanging tree limb and pushed his way through a mass of bushes. Our destination was the banks of Goose Creek in eastern Union County, whose proximity to Charlotte makes it the fastest-growing county in North Carolina. Fowlkes, a biologist with the N.C. Wildlife Resources Commission who works with the Carolina heelsplitter, was going to show me why freshwater mussels and other aquatic organisms have suffered so much in recent years.

We climbed over a fallen tree and walked 20 yards upstream. Fowlkes pointed to a spot where the stream had branched. Something had happened — a tree had fallen, perhaps — to block the original channel, and now the water was being diverted to a new channel.

"Two years ago, I was able to jump across this channel," Fowlkes told me. "Now it's 20 feet wide and getting wider." Trees had toppled on both banks as the stream undermined their roots.

Fowlkes was quick to say that heavy rains in the past two years had probably combined with development in the watershed to create the problem. "But think of how many tons of sediment have been washed downstream just from this spot," he said.

If aquatic ecosystems are in trouble across North Carolina, much of their predicament is due to good old-fashioned mud. And there's no doubt that much of the increased sediment loads in rivers is caused by construction projects and development in watersheds, especially in the Piedmont. According to a recent study by the N.C. Public Interest Research Group, North Carolina grew so fast between 1982 and 2002 that 383 acres of cropland and forestland were developed *every day* during that time. In the Charlotte metropolitan area alone, comprising Cabarrus, Gaston, Lincoln, Mecklenburg, Rowan, Union and Alexander counties, more than a quarter of the cropland and forestland — about 300,000 acres — was lost to development. This energetic growth was chewing up open space in formerly rural counties such as Union.

Any ground-disturbing activity such as construction can produce sediment in streams. But perhaps the most insidious effects of construction are not the direct impacts from construction sites but the secondary and cumulative effects of all the paved surfaces that are being added to the watershed. As fields and forests disappear, rainwater that once soaked into the ground now rushes down driveways, parking lots and streets to storm drains that dump the stormwater directly into creeks. Stormwater runoff carries oil, fertilizers and other pollutants into the stream, and it creates even more sediment in the stream itself.

"One way of looking at stormwater runoff is to think of a garden hose," Fowlkes said. "If you just turned it on gently, the water would create its own little channel. But if you turn it up high, that water pressure will erode your lawn. You've changed your energy input. When you add more impervious surfaces to your watershed, you're changing the energy inputs to rivers and streams by creating more surface flow from stormwater."

Swimming with the Current

Local government officials may get help on how to reduce delays in infrastructure projects through "Swimming with the Current," an effort of the N.C. Department of Environment and Natural Resources, N.C. Wildlife Resources Commission, U.S. Fish and Wildlife Service and N.C. Department of Transportation. A planning booklet and workshops for municipal officials will be available this spring. For information, contact the commission's Habitat Conservation program manager, Shannon Deaton, at shannon.deaton@ncwildlife.org or (919) 733-3633.

Fairview mayor Richard Williams (right) has spent many hours consulting with commission biologist Mark Fowlkes and others on mussel management in Goose Creek, which runs through eastern Union County near Charlotte.

When water changes because of an influx of mud, silt or other pollutants, life downstream is altered. A decline in filter-feeding mussels worsens water quality, and native species give way to opportunistic fish such as carp.

As a creek erodes its banks because of the increased flow of water, fine sediments fill the spaces on the river bottom where the mussels burrow. They can even bury the mussels and prevent them from feeding. Increased stormwater flows can also scour the river bottoms and destroy the habitats of a host of organisms — mussels, crayfish and insect species, the base of the aquatic food chain. Removal of forested buffers along streams can increase stream temperature, affecting some fish species and endangering the mussels that rely on the fish for their reproduction. Sediment that buries mussels also worsens water quality, fills reservoirs and causes flooding, all of which will eventually require expensive fixes.

"When your mussels decline, your fish populations are going, too, and so are aquatic invertebrate populations," Fowlkes said. "And water quality is worsening. That's the cost of increased amounts of paved and hardened surfaces in the watershed."