# Mussel Restoration in West Virginia Streams

Story and photography by Janet L. Clayton

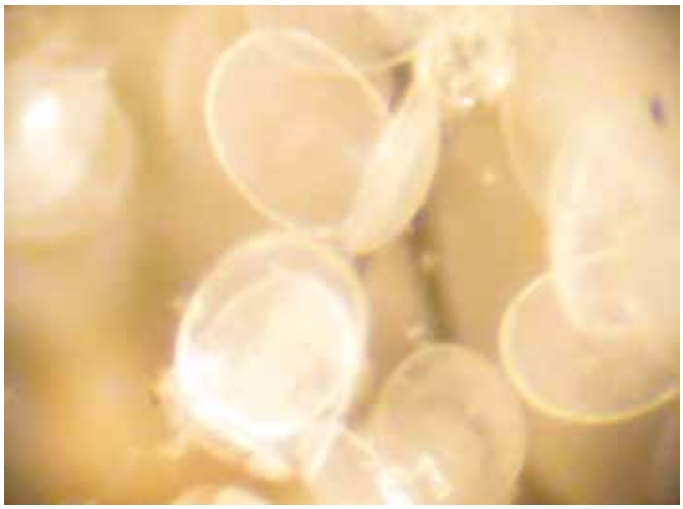
Biologists have identified 62 mussel species living in West Virginia. Just as the canary was historically an indicator of clean air in our coal mines, mussels are indicators of clean water in our streams. Mussels depend on clean water to provide them with food and oxygen, and stable stream bottoms to provide sure footing. At the same time, mussels help filter water in our streams. It has been estimated that 100 mussels can filter 500 gallons of water per day. A bed containing 200,000 mussels can filter one million gallons of water per day – free of charge. Imagine how much money we could save in water treatment costs if our native mussel communities were restored?

As mussels filter water, removing the oxygen and food they need, particulate matter the mussels don't eat is bound up and expelled as pseudofeces that becomes available as a food source for other aquatic life living on the stream bottom. The large muscular foot mussels use to hold themselves in place helps to stabilize the stream bottom, and also to loosen it, again benefiting other aquatic life.

Mussel populations nationwide have been declining in recent years, and those in West Virginia are no exception. Many of West Virginia's mussel populations have been impacted by acid mine drainage (AMD), other poor water quality conditions, and habitat loss. Since the late 1990s, West Virginia has had six significant mussel kills. The most significant of these were the kill on the Ohio River downstream of Parkersburg in 1999 and the complete kill of Dunkard Creek in Monongalia County in 2009. Since 2006 the DNR Wildlife Resources Section (WRS) has been working to restore lost populations. This is a difficult process because mussels have a precarious life cycle. The young must first attach to a fish, or in one known case a mudpuppy, and go through a metamorphosis (change in form) before they drop off, hopefully in suitable habitat, to begin their typically sedentary lifestyle.

*Female pocketbook mussel attempts to attract a fish host with its minnow-like lure which is an extension of its mantle. Note the swollen gills (segmented sections between the two black dots) containing mussel larvae. This is typical of long-term brooders.*

Mussels brood their young, known as glochidia, in pockets within their gills and have three main strategies to get them attached to a host. One group of mussels are generalists that disperse their larvae into the water column, chancing that the larvae come into contact with the correct species of fish host. Some



*Mature Washboard mussel glochidia (larvae). The two valves of mature larvae  uiver and partially close and open. When they come into contact with fish slime, they clamp shut. These larvae are smaller than salt crystals.*

mussel species can attach to many different species of fish, while others can only use one species as a host. A second group of mussels release packets of glochidia, called conglutinants, that resemble some fish food item, such as a maggot. Ideally, the correct host fish will come along and bite down on the conglutinant, breaking it open and releasing the glochidia. A third group of mussels have modified mantle flaps that mimic some type of food for the fish host, such as a minnow-like lure. One example is the pocketbook mussel. The host comes down to what it assumes is an easy meal, and when it attempts to bite the lure, the mussel shoots out a cloud of glochidia, which attach to

*WRS biologist Mike Everhart collects a bag of mussels from the Allegheny River in Pennsylvania. Allegheny River mussels have been relocated to help restore lost populations in the Monongahela, Ohio and Elk rivers in West Virginia.*

*WRS biologists Mike Everhart and Dave Wellman place mussels collected from the Allegheny River into trays for transport to the Monongahela River above Morgantown. The trays allow water to circulate around the mussels and allows mussels to extract oxygen from the water during transport.*

*WRS personnel have constructed a specialized mussel hauling tank which has shelves in which bags of mussels can be laid out. This eliminates the need for trays and reduces handling of the animals.*

the host and absorb nutrients from the fish.

Mussels employ two main brooding strategies. In short-term brooders, the period from egg fertilization to larval dispersal occurs over a short period. Gravid females (having mature larvae) can be found generally during a period of less than a month. With long-term brooders, gravid females can be found during a period of several months, including over winter. Historically, most propagation efforts by biologists have involved long-term brooders because it is much easier to collect gravid females with mature larvae. Short-term brooders have to be observed over a period of time to find them at peak gravid condition. This condition is related mostly to stream temperature which has not been documented for most species, and which can fluctuate greatly depending on weather conditions. Gravid individuals are also more difficult to handle because they tend to readily abort their larvae when stressed. Recent research shows that glochidia that attach to a host within 24 hours of release have the best transformation success rates. For this reason, it is best to have the fish and mussels nearby when extracting the glochidia so that they can be attached to the host fish as soon as possible.

*Short-term brooders when gravid, like these pimplebacks, don't have the heavily swollen gills like the long-term brooders, making extraction of the larvae difficult. As a result, many more individuals are needed to obtain the desired number of larvae. Initial efforts by the WRS in short-term brooder propagation involved stressing the mussels by cooling and warming the water which causes them to abort their larvae. If the larvae were determined to be mature, fish were then inoculated with larvae. More recently, biologists have begun collecting larger batches of mussels after they have been determined to be holding mature larvae and allowing them to release the larvae naturally. These mussels are held at the Belleville Complex, monitored daily, and as mature larvae are released, host fish are infested. Release of mature larvae may occur over a few days to a few weeks. The number of fish infested is determined by the number of larvae released.*

*Mussels coming into West Virginia go through a two-week quarantine at the Belleville Complex to minimize chances of disease and parasite transmission.*

*Federally endangered Northern Riffleshell mussels, are being stocked by WRS and U.S. Fish and Wildlife Service personnel into the Elk River. Mussels were tagged so they can be electronically monitored, even if buried in the substrate. The transmitter can be seen attached to the mussel in the photo at left.*

# Relocation

The easiest method to restore mussel populations is relocating adult individuals from an existing population. This provides sexually mature individuals which naturally repopulate the new area. This method has several drawbacks, however. First, it "robs Peter to pay Paul," as there is no net gain of mussels. Additionally, stealing mussels from the existing population may permanently harm that population. Second, given the intricate life cycle of mussels, the population will probably take decades to recover even if reproduction is successful. There are advantages to relocating at least a few individuals to allow limited natural reproduction to begin immediately, while additional mussels are bred artificially for stocking. Biologists believe that stocking adult mussels also improves the stream bottom for juvenile mussels. Many times while conducting mussel surveys, biologists have found juveniles taking advantage of the loosened substrate around the adult mussels in order to bury themselves.

In 2006, Wildlife Resources Section biologists conducted the first mussel restoration attempt in West Virginia in cooperation with the Pennsylvania Fish and Boat Commission and the U.S. Fish and Wildlife Service (USFWS). Mussels were salvaged from the Allegheny River in Pennsylvania where they needed to be relocated as the result of a bridge demolition project. Over a period of several years, mussels were moved to re-establish populations in the Monongahela River (which was historically impacted by acid mine drainage), the Ohio River (following the massive mussel kill in 1999), and the Elk River (which has had a loss of mussel diversity from historic levels).

West Virginia currently has nine mussel species listed as federally endangered. In order for a species to be removed from the endangered species list, viable reproducing populations must be re-established. In September 2010, in cooperation with the USFWS and Kentucky Department of Fish and Wildlife Resources, WRS biologists received 400 individuals of the federally endangered fanshell mussel. These were stocked into two locations; one on the Kanawha River

Glochidia can be flushed from the gills of long-term brooders such as this fatmucket mussel. This is done by puncturing the gill and then flushing it with water.

The host fish, in this case fingerling largemouth bass, are being infested with larval mussels. The water/glochidia mixture is aerated during the process to keep the glochidia suspended in the water to increase chances they will attach to the host fish.

Mike Everhart

below Kanawha Falls, and one on the Ohio River at Muskingum Island. Both locations already had small numbers of reproducing fanshells, and it is hoped that the added broodstock will allow for increased reproduction and expansion of this species. In 2012, again working with the Pennsylvania Fish and Boat Commission and the USFWS, Wildlife Resources Section biologists collected 200 endangered northern riffleshell mussels from another bridge demolition project and augmented the existing population in the Elk River. Both of these projects are part of much larger multi-state restoration efforts.

*Freshwater drum were used as hosts for the pink heelsplitter as part of the Dunkard Creek restoration efforts. Because there were fewer large fish, infestations were conducted by inoculating the glochidia directly onto the gills on one side of the fish as seen here by WRS mussel biologist Janet Clayton. The infested fish were then stocked directly into Dunkard Creek.*

Photo by Dave Wellman

# Propagation

As part of the Ohio River Restoration Project, WRS personnel are working with The Ohio State University, White Sulfur Springs National Fish Hatchery, and the Ohio River Islands National Wildlife Refuge to propagate mussels for restoration of the area killed by the 1999 toxic event. While Ohio State University and the national hatchery have facilities to actively propagate mussels, Wildlife Resources Section biologists are conducting some propagation efforts by inoculating fish hosts with mussel larvae. They then placed the fish in cages long enough to allow the juvenile mussels to transform and fall off into trays (called cage culturing), or they release the fish directly into the stream to be restored. The WRS provides fish to the White Sulphur Springs hatchery for their propagation efforts, and, with help from national wildlife refuge

*For the Ohio River Restoration Project, infested host fish are caged until the mussel larvae mature and fall to the bottom of the cages. Initially most of the caging was conducted at Stonewall Jackson Lake where the cages were suspended under the marina docks. Here WRS biologists Scott Morrison and Mike Everhart place inoculated fish into one such cage.*

*Photo by Pam Glasser*

*Mussel cages are checked in the spring following infestations. Here juvenile fat muckets at Stonewall Jackson Lake in May 2011 still have byssal threads which are single protein strands that they use to hold onto the substrate. At this point the mussels are combined into fewer cages to let them grow large enough to tag, as seen in these 17 month olds. As the mussels grow, they lose the byssal thread and rely on the large muscular foot to maintain position in the stream bottom. These mussels are tagged and ready for stocking into the Ohio River restoration area. Mussels are tagged so that propagated mussels can be distinguished from mussels that are the result of natural reproduction during future monitoring efforts.*

*The main restoration efforts on Dunkard Creek consists of releasing inoculated fish directly into the creek. WRS biologists Janet Clayton and Mike Everhart conducted the first fish stocking on Dunkard Creek in March 2012. They stocked bluegill inoculated with fat mucket, giant floater, and creeper larvae near Blacks Run.*

personnel, spends numerous hours collecting gravid female mussels for all these propagation efforts. More recently, Genoa National Fish Hatchery and Tennessee Technological University have also provided assistance with propagation.

Wildlife Resources Section biologists expanded mussel restoration efforts in 2012 when they began active restoration of Dunkard Creek in Monongalia County. A complete mussel kill occurred in 2009 within the entire length of the stream, which included nearly 14 miles in West Virginia as well as additional miles in Pennsylvania. Mussels and fish died as a result of poor water quality conditions that led to a toxic golden algae bloom. Initial efforts consisted of inoculating and releasing host fish. In the near future, WRS biologists plan to find sources of adult mussels that can be relocated into Dunkard Creek.

*Janet Clayton is a wildlife biologist with the DNR Wildlife Resources Section stationed in Elkins.*

# Evaluation and Assessment

**In 2012, after five years of active restoration on the Ohio River, WRS and USFWS personnel conducted an assessment of the main restoration area. The results were very promising.**

Mike Everhart

*In 2008, Mitch Osborne (USFWS) and WRS mussel biologist Janet Clayton ready to make the first stocking of mussels produced by the WRS into the restoration area on the Ohio River in Wood County.*

*Mussels are recovering within the kill zone on the Ohio River. These are washboard mussels collected from the main restoration area during 2012 monitoring surveys. The top mussel is approximately seven years old based on the growth rings, believed to be similar to the growth rings on a tree. The bottom two mussels are in their second year.*

*Nine of the 21 species of mussels observed during the 2012 restoration monitoring. They include black sandshell, pink heelsplitter, butterfly, paper pondshell, pimpleback, threehorned wartyback, mapleleaf, fragile papershell, fanshell and fawnsfoot. It is believed that at least 15 species are now naturally reproducing.*