



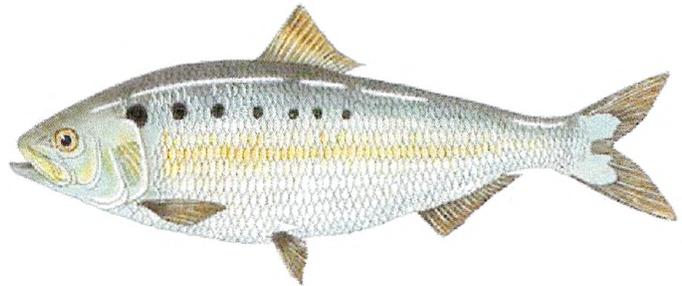
ENVIRONMENTAL MANAGEMENT CENTER
BRANDYWINE CONSERVANCY P.O. BOX 141 CHADDS FORD
PENNSYLVANIA 19317 610/388-2700 • FAX 610/388-1575

The American Shad (*Alosa sapidissima*)

Shad grow to 30 inches long, with a maximum weight of about 12 pounds. They are silver on the sides, with a greenish or bluish-metallic sheen on the back. The scales are large and readily detach when the fish is handled. Shad have one to two, rarely three, rows of dark spots extending along the side from the back edge of the gill cover. The first spot is the largest.

The body is deep from the side and narrow seen head-on. Shad have sharp-edged scales along the belly line, as do other herrings. The dorsal fin is at the center of the back, and the tail is deeply notched. The dorsal and caudal fins are dusky. The caudal fin has a black edge, and the other fins are clear to light-green.

The upper and lower jaws are approximately equal in length, neither jutting past the other. The rear corner of



the upper jaw extends to the rear edge of the large eye. The head has a short, triangular look. Among anglers, the shad is notorious for its thin, easily torn mouth tissue.

Like the salmon, American shad are anadromous. They live in the open-water ocean as adults, entering brackish estuaries and swimming far upstream to spawn in freshwater rivers. They do not normally enter small streams and creeks, as do the hickory shad and the salmon. American shad stay in the main stems of rivers. As marine adults, shad travel in schools extensively along the coast.

Shad run upriver from salt water into fresh water on their spring spawning migration when the water temperature is in the mid-50s to 60 degrees, with peak spawning activity occurring at about 65 degrees. The males travel upriver in schools ahead of the females. Shad

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spawn over sandbars or rocky riffles at night. Females are larger than the males and produce 100,000 eggs on average, with 300,000 a documented high. Shad eggs are not adhesive and are just slightly heavier than water, so they do not readily sink. Instead, they drift along with the current. They hatch in eight to 12 days, depending on water temperature.

Adult shad eat little on their upstream spawning run, although they will strike anglers' offerings. Once spawning is completed, shad eat on their way downriver to the sea. Hatched shad live several months in fresh water, reaching the ocean by their first autumn. Shad stay in salt water for four or five years and until they are about 18 inches long, when they become sexually mature. Then they make their first freshwater spawning run. Some return to their home streams, but others show no migratory pattern. Shad feed mostly on microcrustaceans, or zooplankton, as well as on some species of worms and small fish. While in fresh water, the young feed on insect larvae.





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A Natural and Cultural History of Shad

The huge numbers and excellent flavor of the American shad were once legendary along the East Coast of the United States. From long before the arrival of settlers to the New World, the spring migratory runs of this 20-30" full-flavored silver fish once numbered in *the tens of millions*, featuring so many fish that the rivers were described as "black" and "boiling." Their range included accessible eastern streams lying between Newfoundland, Canada and northern Florida. The Latin name for the species is *Alosa sapidissima*, meaning "most delicious, or savory, herring." Glowing historical accounts reach back to the earliest colonial days, where the "innumerable" fish, both fresh and preserved through pickling or salting, was a central part of settlers' diets, as it was for Native Americans before them.¹

Today, many people have never heard of the fish. Once denied access to its former spawning streams through dam blockages and pollution, the fish's numbers plummeted. At the same time, they were over-harvested in the ocean. Now, through a national restoration effort, this important symbol of our natural and cultural heritage is making a comeback.

The American shad is the largest North American member of the herring family, commonly reaching about 30" and 4-8 pounds. It is an anadromous fish that spends the majority of its adult life at sea, returning only to freshwater in the spring to spawn. Like salmon, shad return to the stream of their birth, their "natal" stream, to spawn.

Beginning in March or April, shad congregate in the bays, sounds, and estuaries below their natal rivers, adjusting their physiology from salt- to fresh water. Then, about the same time as the shadbush (*Amelanchier spp.*) blooms, they stop eating and move en masse upstream, sometimes traveling hundreds of miles before spawning (for example, into upstate New York on

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¹ Weslanger, C. A., 1953. *Red Man on the Brandywine*, Wilmington, DE., Chapter 13, page 1.

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both the Delaware and Susquehanna Rivers). Not all shad die after spawning, instead returning downstream to the ocean where the cycle may begin again.

During the migratory runs, the males travel upriver in schools ahead of the females. Shad spawn over sandbars or rocky riffles at night. Females, which are larger than the males, produce 100,000 eggs on average, with 300,000 a documented high. Shad eggs are not adhesive and are just slightly heavier than water, so they do not readily sink. Instead, they drift along with the current, settling to the bottom as they gain weight and lodge in place. The eggs develop and hatch in eight to twelve days, depending on water temperature. The young shad or fry feed on freshwater plankton and aquatic insects throughout the summer. When the fall rains arrive and the water cools, surviving young descend their birth streams in large numbers, eventually heading out into the open ocean. East Coast shad then form large schools, wintering more or less together off the mid-Atlantic. Over the summer months, they range as far north as the Bay of Fundy, off Nova Scotia. They feed exclusively on oceanic plankton. After three-to-five years at sea, the natural phenomenon cycles around again, and those shad ready to spawn congregate in the bays, sounds, and estuaries below their natal rivers.

Such an abundant and tasty fish naturally caught the attention of settlers. For example, early Swedish settlers in Wilmington, Delaware, are reported to have brought their fish planks with them among other household effects.² The planking of fish was and is a favorite method of cooking shad, used by Native Americans as well as settlers. Traditionally, the fish is nailed or attached to a previously warmed oak plank and baked by placing the plank close to the coals of a fire. An engineer with the Swedish colony, Peter Lindstrom, wrote in his *Geographica Americae* (1654-56), “shad ... is a very fine flavored and excellent tasting fish.”³

Shad continued to be as important to the colonists as they were to the Native Americans. Using fishing skills such as brush nets and rock-crib traps learned from the Indians, the early settlers salted the fish away for the rest of the year. When Connecticut settlers laid claim to the northern tier of Pennsylvania in the 1750s, they quickly tried to establish commercial fishing rights to the shad runs in the Susquehanna, which was only resolved by war. Meanwhile, the

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² From Ellwanger, G.H., 1902. *The Pleasures of the Table*. Doubleday, Page, & Co., New York, p. 255, as reported in Raasch, 1991, p. 12.

³ Also as reported in Raasch, 1991, p. 13.

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settlers introduced the use of nets and seines for large-scale harvesting.⁴ Overall, fishing or trading for shad was so widespread in colonial America, it is said that “no family was without its share.”⁵ Settlements and areas on rivers were named after shad, such as Shad Landing, Maryland, and Shadwell, Virginia, where Thomas Jefferson was born. Shad even had a role to play in the American Revolution: they have been credited with helping to save General Washington’s troops at Valley Forge. The spring run of 1778 arrived in time to feed and strengthen the starving troops.⁶ Shad have even been named “the Founding Fish” by author John McPhee, due to their central role in early American life.⁷

The importance of shad continued in the early decades of the new American Republic. It is reported, for example, that the annual harvest of shad in the upper Susquehanna River was limited only by the availability of salt needed for their preservation.⁸ Yet during this time, the increasing blockage of spawning rivers by dams and other impediments, combined with degradation of water quality by new industries and relative overfishing, initiated a downward spiral in shad populations. Still, a commercial shad industry was able to establish and maintain itself, especially in larger rivers, until the early 20th century. In fact, American shad were the largest commercial fishery in the mid-Atlantic. “Just as the sacred cod of Massachusetts is the accepted emblem of the Bay State, so the shad may rightly be considered the piscatorial representative of the states bordering the Chesapeake,” wrote Rachel Carson in the *Baltimore Sun* in 1936. Shad is the state fish of Connecticut today.

Still, shad are naturally most abundant in the middle Atlantic region. In fact, the Delaware River and its tributaries are considered to have historically supported the largest population of American shad over all East Coast rivers.⁹ Consequently, the Susquehanna and

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⁴ From U.S. Fish and Wildlife Service, et al, undated, “Migratory Fish restoration and Passage on the Susquehanna River,” p. 1.

⁵ *Ibid*, p. 1.

⁶ “The most memorable day was the one early in spring when schools of shad came swimming up the Schuylkill --- thousands upon thousands of beautiful, fat shining shad. The whole camp turned out to catch shad. The river so swarmed with fish that each haul of the net brought in hundreds. That night for the first time since the army had moved to Valley Forge there was not a hungry man in camp; each soldier went to bed with a belly stuffed with shad.” (p. 179 of a chapter called “The Revolution” in “The Pennsylvania Dutch” by Frederic Klees, published 1951 by Macmillan Co.)

⁷ See McPhee, 2002, *The Founding Fish*.

⁸ From U.S. Fish and Wildlife Service, et al, undated, “Migratory Fish restoration and Passage on the Susquehanna River,” p. 1.

⁹ From U.S. Fish and Wildlife Service, et al, undated, “American Shad Restoration in the Delaware River Basin,” fact sheet.

(HISTORY OF SHAD—PAGE 4)

Delaware Rivers were among the most abundant commercial fisheries, supporting fish hauls of over 6 million and 10 million pounds respectively in the late 1890s and early 1900s. The well-known Philadelphia painter, Thomas Eakins, depicted shad fishermen at work in his *Shad fishing at Gloucester on the Delaware River* (1881). Today, these fisheries are a tiny fraction of what they were due to habitat loss and fishing pressure. There are no commercial shad fisheries left on the Susquehanna and only one on the Delaware River at Lambertville, New Jersey. Even today, though shad numbers are far below their 1900 levels, shad and its roe are the most popular springtime fishery on the Delaware River and are marketed commercially, with the annual harvest ranging from \$30,000 to \$150,000 dockside value between 1980 and 1989.



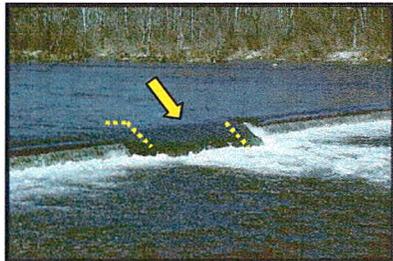
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Fish Passage Options

Many fish species migrate hundreds of miles between suitable habitats in oceans and streams. Structures placed across a stream can have dramatic impacts on the movements of fish within a stream.

Channel spanning structures such as dams and weirs are barriers to fish passage. These structures block channels and make areas of habitat inaccessible to aquatic organisms. Many options exist for enhancing fish passage in these situations.

Restoring fish passage by installing fishways or removing barriers provides immediate improvement in and recovery of fish populations, as well as the restoration of aquatic habitat. Some options for enhancing fish passage in the Brandywine River include the following.



Dam Notching

Notching involves the partial removal of a dam. The notch creates a bypass to enhance fish passage. Dam notching allows the structure to remain intact or be removed later. Notching a dam is done gradually to ensure the release of sediment stored above the dam does not adversely impact water quality downstream.



Denil Fishway

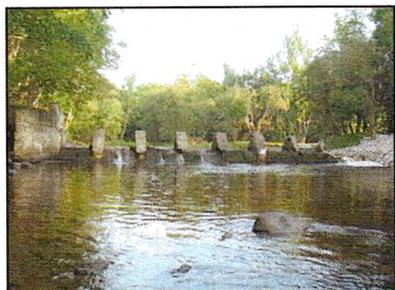
Denil fishways use a series of symmetrical baffles to redirect the flow of water, causing fish to swim around a barrier. Like railway switchbacks, these “fish ladders” can accommodate steep grades and require limited for construction. The image at left shows a dam in Rock Creek Park in Washington, DC with a concealed fishway to enhance the aesthetics.



Rock Ramp

Rock ramps use boulders or timbers to create pools and small falls resembling natural habitat features. Due to the length of channels needed for rock ramps, such structures are appropriate for short barriers. The diagram at left shows a dam converted to a rock ramp that mimics a natural channel.

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Before dam removal

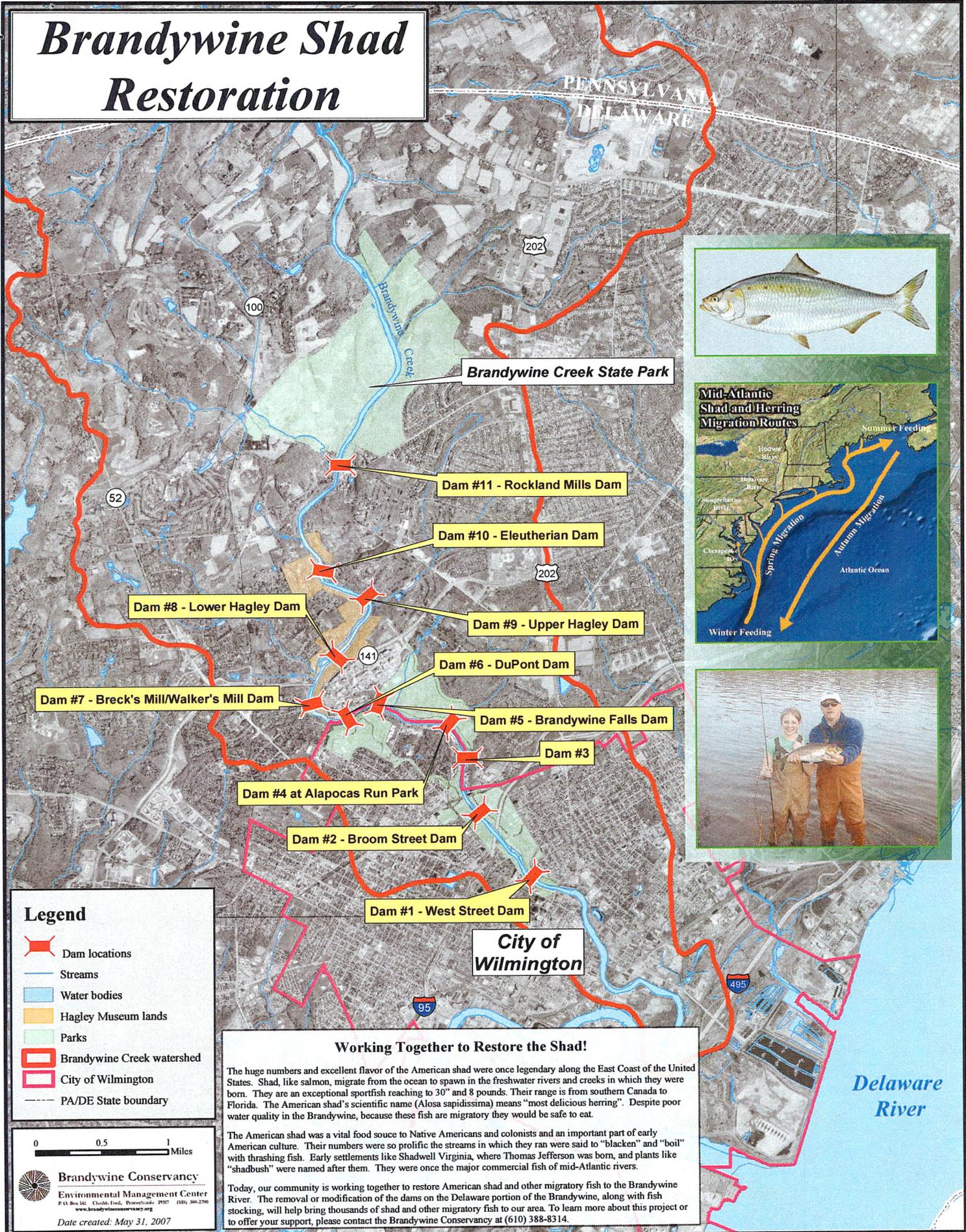


After dam removal

Dam Removal

The removal of a dam restores fish migration and provides habitat for juvenile fish. Dam removal is the least expensive option for enhancing fish passage, requiring no maintenance and enabling the maximum possible fish passage. The images at left show the Cuddebackville dam on New York's Neversink River—a tributary of the Delaware River where efforts are also underway to restore American shad—before and after removal.

Brandywine Shad Restoration



Legend

- Dam locations
- Streams
- Water bodies
- Hagley Museum lands
- Parks
- Brandywine Creek watershed
- City of Wilmington
- PA/DE State boundary

0 0.5 1 Miles

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Date created: May 31, 2007

Working Together to Restore the Shad!

The huge numbers and excellent flavor of the American shad were once legendary along the East Coast of the United States. Shad, like salmon, migrate from the ocean to spawn in the freshwater rivers and creeks in which they were born. They are an exceptional sportfish reaching to 30" and 8 pounds. Their range is from southern Canada to Florida. The American shad's scientific name (*Alosa sapidissima*) means "most delicious herring". Despite poor water quality in the Brandywine, because these fish are migratory they would be safe to eat.

The American shad was a vital food source to Native Americans and colonists and an important part of early American culture. Their numbers were so prolific the streams in which they ran were said to "blacken" and "boil" with thrashing fish. Early settlements like Shadwell Virginia, where Thomas Jefferson was born, and plants like "shadbush" were named after them. They were once the major commercial fish of mid-Atlantic rivers.

Today, our community is working together to restore American shad and other migratory fish to the Brandywine River. The removal or modification of the dams on the Delaware portion of the Brandywine, along with fish stocking, will help bring thousands of shad and other migratory fish to our area. To learn more about this project or to offer your support, please contact the Brandywine Conservancy at (610) 388-8314.

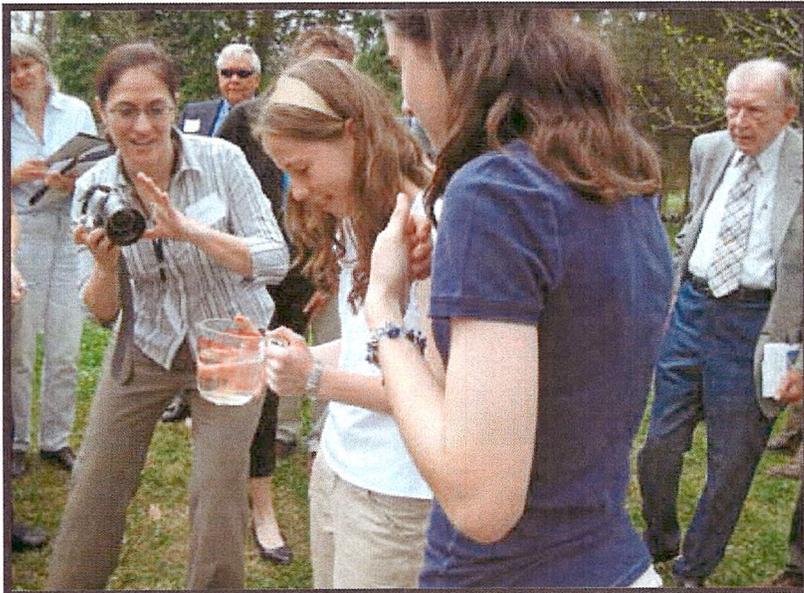
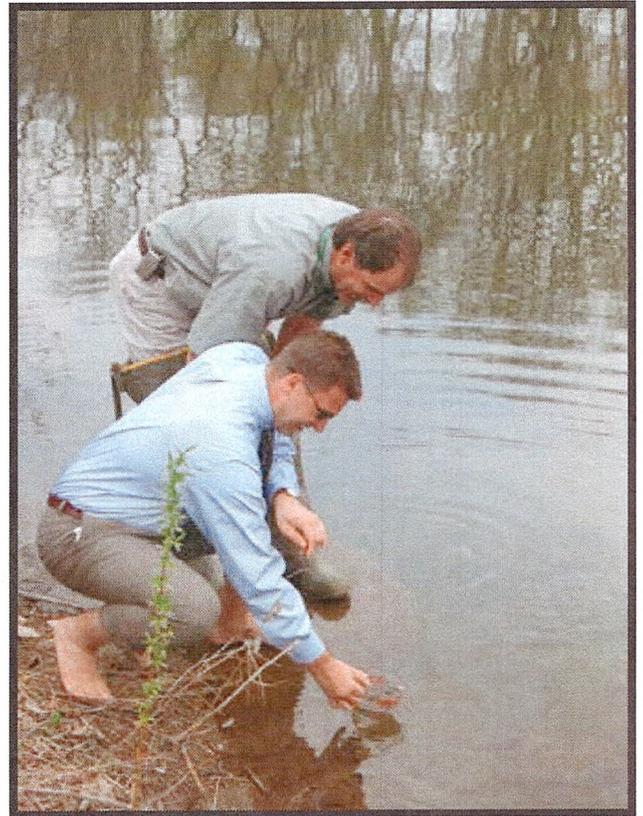
Delaware River

REBIRTH OF THE BRANDYWINE RIVER

On April 24, 2007, over 70 people gathered at the Hagley Museum in Wilmington, Delaware to support the Brandywine Shad Restoration project. This collaborative project aims to restore American shad on the Brandywine creek in Delaware and Pennsylvania. As part of the event, participants released 8,000 juvenile shad into the creek in hopes that in five years, when they are ready to return from the ocean, they will have free passage back to the upper reaches of this creek.

In the 1700s, the Brandywine creek likely supported hundreds of thousands of American shad. Today, over 20 dams, created to power historic paper mills and other industries, block access to historic upstream spawning habitats and now only a handful of shad pass through these waters each year. In fact as the event proceeded, several dozen frustrated Hickory shad tried unsuccessfully to jump over the river's lowermost dam.

In 2003, NOAA funded a feasibility study to look at options for restoring this river system. As a result of the study, local non-profit organizations, state agencies and others began to plan for dam removal and fish ladders on the river. Over 500 students from the Wilmington Friends School signed a petition asking the city's mayor to restore shad to the river.



Project partners are already removing several dams on the Delaware portion of the creek. Now, NOAA is funding a second engineering analysis to examine fish passage options at the remaining blockages throughout Pennsylvania. Once fully implemented, this project will restore fish passage for migratory fish at over 20 dams throughout the Brandywine Creek watershed, at a cost of about \$3.5 million.

"We are witnessing the rebirth of the Brandywine," noted George Weymouth, chairman of the Brandywine Conservancy's Board.