

Restoring Fish Passage from the Chesapeake Bay

by Amy Lambert and Chris Carbone

FOR more than 100 years, the migratory fish of the Chesapeake Bay have been cut off from their historic spawning grounds by barriers introduced through decades of development. But now that's changing, due to 23 separate fish passage projects completed as part of the environmental mitigation program associated with the \$2.4 billion replacement of the Woodrow Wilson Bridge. This restoration initiative, a \$10 million effort that opened 26 miles of historic spawning habitat in five streams in and around Washington, D.C., was realized through the collaboration of federal, state, local and private organizations. KCI Technologies, a consulting engineering firm based in Hunt Valley, Md., designed the projects.

The purpose of the Woodrow Wilson Bridge Project is to replace the aging drawbridge that joins Maryland and Virginia along Interstate 95 over the Potomac River. The new bridge will carry a much greater traffic volume and stand higher above the water so it doesn't have to open so frequently. To date, the first bridge structure and much of the interchange work on both sides has been completed. The second bridge structure will be finished in 2010. With a total of 12 lanes, six per structure, the Woodrow Wilson Bridge will be the world's largest drawbridge.

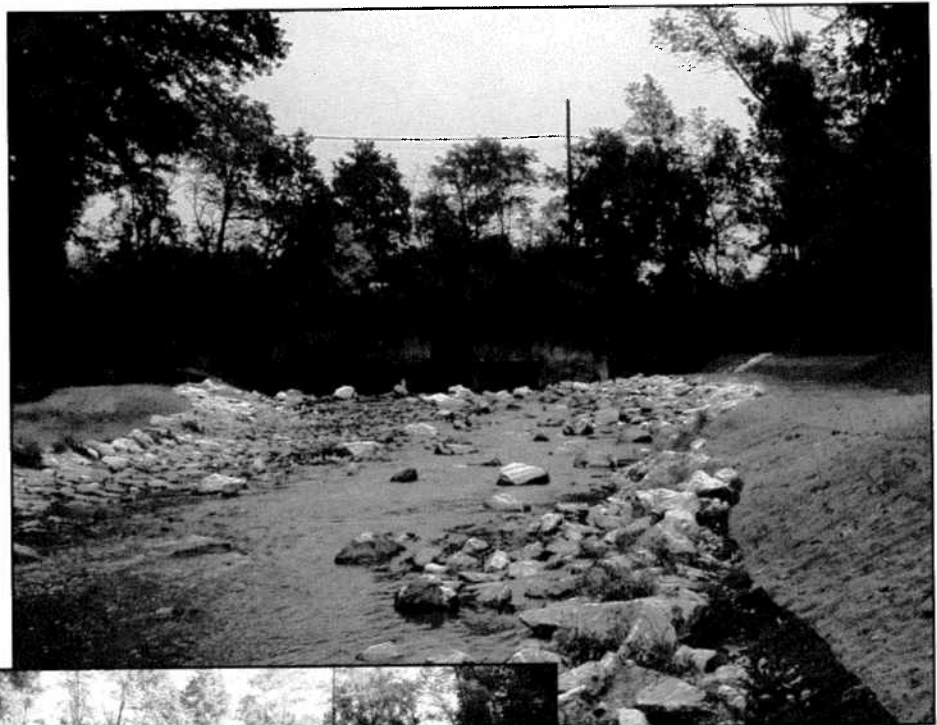
The Woodrow Wilson Bridge Fish Passage Program is a mitigation effort aimed at restoring native species of the Chesapeake Bay Watershed to their original spawning grounds in the tributaries of the Potomac River.

So, what happened to the native species? As the D.C. metro region developed over the past century, natural

resources like stream corridors, parks and water frontage suffered from degradation and habitat loss. Over time, the streams—which average about a foot deep and 40 to 80 feet wide at base flow—were altered by a mix of active and abandoned

sary components of the burgeoning urban landscape, stream conservation was not accorded the same level of concern in past decades that it receives today. Thus the current conditions.

The Maryland State Highway



Blockages resulting from erosion and culverts in Indian Creek were addressed with a rock ramp and bank stabilization.

water and sewer lines, roadway culverts and dams prevented fish from swimming upstream to spawn.

While many of these impediments were, and in some cases still are, neces-

Administration (SHA) is one of the bridge project's sponsoring agencies, along with the Federal Highway Administration, the Virginia Department of Transportation, and the District Department of Transportation. As one of the parties responsible for dealing with the waterway and wetland impacts resulting from bridge and highway construction, SHA recognized the need for restoration of the Potomac's tributaries. They started

working closely with the Maryland-National Capital Parks and Planning Commission, the National Park Service and the U.S. Department of Agriculture to incorporate fish passage as a mitigation

measure. These agencies, operators of the land on which the streams reside, agreed to the fish passage program, but they had to be convinced that the proposed

The streams would have to be dewatered so track vehicles could move earth and deposit tons of boulders, gravel and stone. It would be a major undertaking, but SHA was convinced that natural fish passage systems were appropriate.

“natural” fish passage measures were the right solution, because both the cost and amount of effort would be significantly higher than that of the more common fish ladder.

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Indian Creek before. Stream corridors suffered from degradation and habitat loss due to erosion and abandoned utility lines, concrete fords, dams and grade control structures.

but SHA was convinced that natural fish passage systems were appropriate, given that all the streams are located in the greater metro area’s parklands.

As SHA’s design consultant, KCI Technologies had some homework to do. Their engineers and scientists were presented with the challenge of convincing

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their counterparts at the agencies that natural fish passage design was not only appropriate, but also feasible. They noted that while this approach entailed considerably higher costs up front, it would be a better solution in the long run because it would be maintenance-free and ensure the natural integrity of the parklands. At the time, only a limited number of credible research papers had been published on the subject, so the design team visited sites across the U.S. and consulted with experts from around the world. Ultimately, their efforts resulted in enough analytical data to sway the decision toward a natural approach.

“This was the first time that a fish passage project of this size, scale and type had been attempted in a highly urbanized area,” said KCI Vice President Charles H. Hegberg, who oversaw the initiative on the consulting side. “We quickly realized that, if successful, the project could become a guide



An engineer takes precise measurements of flow velocity after construction at Northwest Branch, allowing him to calculate discharge and determine whether various species can swim upstream.

for urban fish passage efforts around the country.”

The stream systems were located in two physiographic regions—piedmont and coastal plain—with different morphologies. The research team identified two fish passage systems that they felt would adequately address the stream blockages in each of these two regions—the rock ramp (or riffle grade control structure) for the coastal plain, and the flow constrictor/step pool for the piedmont. Although both approaches mimic natural streams, both required modifications to accommodate the flash-floods often encountered in urban areas, and the weak-swimming species of the Chesapeake Bay Watershed—American and hickory shad, alewife, blueback herring, white and yellow perch, and striped bass.

Rock ramp structures had been installed in locations throughout the U.S. and Canada,

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but never under the urban conditions associated with Wilson Bridge program, with multiple locations along a stream corridor in order to provide passage throughout. As for step pool structures, the research and design methodology was still only in the preliminary stages at the time.

As a result, the team had to develop and calibrate new models using data on fish physiology and behavior, flow depths and velocities, and channel structure. To accommodate the native species, one- and two-dimensional models were developed to incorporate complex equations such as rapidly and gradually varied flows, submerged weir flow, and energy dissipation analysis to prove that the structures met design criteria while remaining stable during extreme, storm-related conditions. Engineers took precise measurements at natural step pool/boulder cluster systems in



The new 12-lane Woodrow Wilson Bridge replaces a six-lane crossing that produced one of the most notorious bottlenecks in the nation.

Rock Creek Park to calibrate the models and subsequent designs.

Flow depth was a considerable issue. In urban streams, flow rates vary greatly, with base flows generally low and storm-related flows often high, with considerable increases in velocity. A shallow stream can become a raging torrent, twice as wide, more than six feet deep and flowing two to three times faster after a major storm event.

The program created an opportunity to address the initial goal of reopening historic spawning grounds while simultaneously addressing aesthetic and ecological issues. Designs were coordinated with each park's resource management priorities and plans. The team held meetings with stakeholders to develop a consensus on stone characteristics, and approval was sought before any stone was placed on site. Designers considered rippling or cascading flow patterns, flow characteristics (fast shallow, slow

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deep, eddying), cascading water sounds, and plant selection. All of these features were implemented at one point or another within the project area.

For the most part, construction of the various projects occurred simultaneously over a three-year period, with the final project ending in 2005. Stones were placed by machine. Crews consisted of five to 10 people on site during construction, with two inspectors per site.

With design and construction com-

plete, all 23 fish passage projects are now being monitored to verify success and are exceeding expectations. Monitoring is conducted after significant storm events, and a report is produced each year to document the visual verification and trapped collection of eggs upstream. The natural systems are aesthetically compatible with the parklands and require little or no maintenance. They have proven sustainable through storms producing more than 10 inches of rainfall and one of the

wettest years on record.

According to a spokesperson for the Maryland-National Capital Park and Planning Commission's Park and Planning Development division, the projects "created not only a natural looking stream with minimum annual maintenance, but aesthetically, the fish passage restoration sites are a vast improvement over the pre-construction conditions."

This spring, fish were spawning further upstream in all five tributaries than they have in nearly a century although they have yet to reach the fish passage

They have proven sustainable through storms producing more than 10 inches of rainfall and one of the wettest years on record.

structures located at the upper reaches of each stream. Next year will be telling, as tens of millions of herring, stocked at the upper regions nearly four years ago, reach maturity and are expected to return for the first time to their birth place.

The Woodrow Wilson Bridge Fish Passage Program can serve as a model for other project teams using the rock ramp and step pool structures to restore large river systems to their natural channel pattern, plan and profile. The program's success has resulted in several awards, including a Globe Award from the American Road and Transportation Builders Association, an Outstanding Civil Engineering Achievement Award from the Maryland Section of the American Society of Civil Engineers, an Environmental Excellence Award from the Association of Environmental Professionals, and merit awards from the Maryland Chapter of the American Council of Engineering Companies and Mid-Atlantic Construction magazine.

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