SOUTHEAST WHITE OAK RIVER SHELLFISH RESTORATION PROJECT

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Background

The 42-mile-long White Oak River is one of the last relatively unblemished watery jewels of the N.C. coast. The predominantly black water river meanders through Jones, Carteret and Onslow counties along the central N.C. coast, gradually widening as it flows past Swansboro and into the Atlantic Ocean. It drains almost 12,000 acres of estuaries -- saltwater marshes lined with cordgrass, narrow and impenetrable hardwood swamps and rare stands of red cedar that are flooded with wind tides. The lower portion of the river was so renowned for fat oysters and clams that in times past competing watermen came to blows over its bounty at places that now bear names like Battleground Rock. The lower river is also a designated primary nursery area for such commercially important species as shrimp, spot, Atlantic croaker, blue crabs, weakfish and southern flounder.

But the river has been discovered. The permanent population along the lower White Oak increased by almost a third since 1990, and the amount of developed land increased 82 percent during the same period. With the growth have come bacteria. Since the late 1990s, much of the lower White Oak has been added to North Carolina’s list of impaired waters because of bacterial pollution. Forty-two percent of the rivers’ oyster and clam beds are permanently closed to shellfishing because of high bacteria levels. Fully two-thirds of the river’s shellfish beds are now permanently off limits or close temporarily after a moderate rain. State monitoring indicates that increased runoff from urbanization is the probable cause of the bacterial pollution.

Seeking a Solution

The N.C. Coastal Federation, a non-profit conservation group headquartered in Carteret County about 10 miles from the White Oak River, partnered with two state agencies – the N.C. Division of Water Quality (DWQ) and the N.C. Department of Transportation (DOT) – and Cedar Point, a small town in westernmost Carteret County on banks of the river. The partners received a Section 319 Nonpoint Pollution Control grant in 2006 to study four small watersheds along the southeast White Oak in Cedar Point – Dubling and Boathouse creeks, Hills Bay and the area north of the N.C. 24 bridge to Swansboro. All had been closed to shellfishing in last five years and appear on North Carolina’s 2005 303(d) list.

The project’s broad goal was to build the foundation for the restoration of shellfish waters in the White Oak. It attempted to do that by: 1) Determining where the bacteria were coming from and how they were getting into the water, 2) Educating the public about stormwater and its effects on water quality, 3) Developing TMDLs for three of the watersheds, 4) Crafting Watershed Implementation Plans to meet the TMDLs, and 5) Identifying sites to install best-management practices (BMPs)

Ultimately, the partners hoped that the study would begin to reverse the trend of shellfish closures in the White Oak.

Testing the Water

Much of the first two years of the study were spent taking water samples to test for fecal coliform bacteria. Fecal coliforms are the indicator species used by the state to determine shellfish closures.

In the most comprehensive bacteria sampling ever done on the White Oak, 25 trained volunteers, following a quality-assurance plan approved by DWQ and EPA, took 220 samples from 70 sites in the four watersheds. The intensive sampling was needed to supplement the state’s more limited testing in order to better inform the computer models that would devise the TMDLs.

To try to pinpoint pollution “hotspots” in order to determine the best locations for BMPs, the volunteers went far upstream from the state’s routine sampling stations, which are generally at the mouths of the creeks. They sampled bays, creeks, storm drains, roadside ditches, boat ramps and mosquito canals. All the samples were analyzed at a state-certified laboratory.

Eighty-nine percent of the samples exceeded the bacteria standard for shellfish waters. Of the 113 samples taken from the largest watershed, Boathouse Creek, all but three exceeded the standard. At many of the sites, the bacteria levels were hundreds of times higher than the standard. Bacteria levels in some of the samples from ditches that drain N.C. 24, the main road through the watersheds, were tens of thousands of times higher. The levels generally increased at all sample sites after a rain.

The University of North Carolina's Institute of Marine Sciences volunteered to do limited genetic testing on samples with the highest bacteria levels. Those tests confirmed that the bacteria came from animals, not humans.

Sources vs. Flow

Those tests confirmed on-the-ground observations. The samplers didn't find many obvious sources of human pollution. There are no sewer plants dumping into the watersheds and no industrial discharges. They didn't find illicit pipes, dog pens at the water's edge or failing septic tanks.

Instead, the samplers found a severely altered landscape – forests that have been cut down and replaced with parking lots, roads that have been widened, farm fields that have been replaced with rooftops and driveways. A maze of ditches, pipes, culverts and swales crisscrosses the land. They are designed to do one thing – quickly move runoff to the nearby creeks.

The study's partners concluded that trying to reduce the sources -- deer, raccoons or pets -- was unreasonable. They, instead, turned their attention to the land. Fixing the land by attempting to mimic natural drainage patterns would reduce the flow of runoff into the creeks. It was a more practical alternative and offered a reasonable chance of meeting the study's goals. Restoring natural drainage patterns to reduce the flow of runoff became the focus of the watershed plans that were devised to meet the TMDLs.

TMDL Modeling

TMDLs of fecal coliform were computed for Boathouse Creek, Dubling Creek and Hills Bay. A TMDL wasn't developed for the area north of the N.C. 24 bridge because the hydrodynamics weren't conducive to using the modeling approach. That area, however, was included in the watershed plans.

A variety of data at the watershed scale were used to identify potential fecal coliform contributions. The potential fecal coliform contributions were estimated using project monitoring data, landowner surveys and Geographic Information Systems (GIS) data coverage including land use, property and soils. DOT is the lone National Pollution Discharge Elimination System (NPDES) permitted stormwater point source in the watersheds.

The linked watershed and Tidal Prism modeling approach was used to estimate current fecal coliform load from watersheds and to simulate fecal coliform concentrations in the watersheds. The long-term model results were used to establish allowable loads for each restricted shellfish harvesting area. Since the real-time model simulation was used to establish TMDLs, it accounts for the seasonal variability and critical conditions, which thereby represents the hydrology, hydrodynamics and water quality condition of each selected restricted shellfish harvesting area. The load was then allocated to sources (land use) by determining the proportional contribution of each source based on animal/source density per land use acre times the fecal coliform production.

One of the critical tasks for these TMDLs is to determine current loads from all potential sources in the watershed. The procedure needs to account for temporal variability caused by the seasonal variation and the wet-dry hydrological conditions. Long-term model simulation was conducted to simulate fecal coliform concentration in the water bodies. The long-term daily mean load was estimated for each watershed based on the watershed model results. These results were then used to estimate the current load condition. The allowable loads for each restricted shellfish harvesting area were then computed using both the median water-quality standard for shellfish harvesting of 14 Most Probable Number/100ml and the 90^{th} percentile standard of 43 MPN/100ml. An explicit Margin of Safety of 12 percent was incorporated into the analysis to account for uncertainty by lowering the 90^{th} percentile target from 43 to 38.

The goal of load allocation is to determine the estimated loads for each drainage area while ensuring that the water quality standard can be attained. For restricted shellfish harvesting areas, the 90th percentile criterion requires the greatest reduction. Therefore, the load reduction scenario was developed based on the 90th percentile water quality standard. The load reductions needed in the watershed of each restricted shellfish harvesting area to meet the shellfish criteria with a margin of safety are: Dubling Creek, 14 percent; Boathouse Creek, – 70 percent; and Hills Bay, 55 percent.

These are the loading reductions required from all sources taken collectively.

Watershed Plans

The project's partners devised watershed plans, which usually aren't included with TMDLs. Following EPA's Nine Key Elements, the plans outline a long-term, broad strategy that attempts to overcome the traditional failure of individual stormwater controls by employing varied integrated measures throughout the four watersheds. The plans are focused mainly on reducing the flow of runoff into the impaired waters by infiltrating or reusing runoff and not solely on source reduction. This was a rather novel approach that EPA and DWQ were eager to attempt.

Among the 33 specific BMPs included in the plans are infiltration areas aimed at reducing flow at known bacterial "hotspots," public education on source reduction, individual homeowner BMPs using low-impact development and other green infrastructure techniques and local regulations or ordinances designed to more effectively control stormwater runoff. The plan recommended using incremental 319 grants to install the BMPs over time.

Outcomes and Conclusions

This project has already helped clean up the White Oak River, and not a shovel of dirt has yet been turned on any of its recommended BMPs. Just as this project began, Wal-Mart announced plans to build a store in Cedar Point, in the headwaters of Boathouse Creek. The company needed the land rezoned and its site plan approved. At the packed public hearing of the Town Council, citizens and board members expressed grave concerns about what the proposed 16 acres of parking lot and rooftop would do to water quality in the creek.

The town board refused to rezone the land until Wal-Mart agreed to better control stormwater from the site. After several months of discussions, the company designed a stormwater system that treated 10 times as much runoff than state rules at the time required. It also agreed to use pervious pavement in its parking lot, and the town waived a landscaping requirement to allow the company to build large bioretention cells in the parking lot to treat runoff.

A year later, as the bacteria sample results were coming in, the project played a prominent role in the N.C. Coastal Federation's efforts to strengthen North Carolina's coastal stormwater regulations by using project's sampling results to illustrate the issues. The group held two community meetings about the project and took reporters out on the river. The White Oak River became the face of a failed policy. In the face of stiff opposition, the N.C. General Assembly passed more effective stormwater regulations.

DOT, a project partner, has committed to tackling the two storm drains that convey runoff into Boathouse Creek. Project sampling showed that discharges from the drains routinely contain bacteria levels that are tens of thousands of times higher than the state standard.

Even before the project was completed, Cedar Point was making plans to follow up on the watershed plans' recommendations. It applied for and received another 319 grant to do implement some of the recommended BMPs. As part of the project, it and a neighboring town hope to develop a stormwater ordinance that would encourage LID and other green infrastructure techniques in future commercial and residential construction. Cedar Point also intends to use LID techniques to control stormwater at its town hall and will partner with a state agency to employ such techniques in people's yards and businesses.

While it has already led to water-quality benefits, the project, we think, also illustrates some serious flaws in the strategies state and federal officials use to control stormwater, now the largest source of water pollution along the N.C. coast. Those strategies focus almost entirely on reducing the sources of pollution. That's what the modeling software attempts to do. That's what the engineers who employ those models were trained to do. As this project shows, it’s an impossible task when the sources are mostly natural or otherwise not easily traced. Where the bacteria are coming from isn’t as important as how they’re getting into the water. Reduce the flow and you reduce the problem.

Finally, we suspect that many of the tens of thousands of acres of impaired shellfish waters along the N.C. coast are pretty much like the ones we studied here – moderately developed watersheds with no major industry, sewer plants or other point source. Like Boathouse Creek or Hills Bay, the land around them has been ditched and piped, its forests replaced with parking lots, rooftops and driveways. Deer, raccoon and Fido and Fifi are main sources of bacteria. Do we have to spend another three years and $200,000 to figure that out? If so, meeting the CWA’s mandate to restore these impaired waters is a goal few people reading this will be alive to see. We think there must be a better way. Many state agencies offer general permits for activities that meet a broad set of criteria and circumstances because they know the outcome. We suggest that EPA and DWQ devise a general TMDL that could be applied to similar watersheds that are affected by similar problems.

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