Research Helps Created Wetlands Come to Life

Each time a new development or road fills or drains a Virginia wetland, federal and state laws require that the Commonwealth restore or create a wetland of similar size.

The laws are an outgrowth of the 1977 Clean Water Act, which has led to a policy of "no net loss" of wetlands on a national scale. More than half of the natural wetlands in the contiguous United States have been lost to development since European colonization—along with the vital ecosystem services they provide.

Researchers at VIMS are now collaborating with the Virginia Department of Transportation (VDOT) to study how fast and to what degree newly created wetlands develop into mature, fully functional wetlands like the ones they are meant to replace.

VIMS wetlands expert Dr. Jim Perry, who has been studying mitigation of tidal and non-tidal wetlands since the late 1980s, says his group is helping to "figure out a better way to bring created wetlands to a natural state, so that resource managers can use that information to jumpstart the restoration process."

Adds Perry, "no-net-loss has little meaning if mitigated wetlands don't recycle nutrients, trap sediments, store water, or provide habitat for fish and wildlife like their natural counterparts."

Perry and his graduate students have spent the last few years studying these issues at a created wetland in Charles City County near the Chickahominy State Wildlife Management Area. VDOT created the site as mitigation for the disturbance of wetlands incurred during the construction of Route 199 around Williamsburg. The new 40-acre wetland is about 7 years old.

David Bailey (L) measures carbon dioxide levels within an experimental chamber as Azure Bevington (R) looks on.

The site forms the headwaters for Barrows creek, a small waterway that flows into the Chickahominy River, which in turn flows into the James River and Chesapeake Bay.

A current focus of Perry's group is to better understand how adding mulch to a created non-tidal wetland might affect the restoration process. VIMS graduate student David Bailey has begun to study this question by comparing the health and vitality of plots within the Chickahominy wetland to which he has added various amounts of compost made from wood and yard waste.

Creating a wetland from scratch can be a difficult process, says Bailey. It typically requires the use of heavy machinery to lower the ground surface so that it intersects the water table or collects rainwater. But doing so also compacts the soil and removes existing vegetation, accumulated organic material, and seeds.

As anyone who has trudged through a muddy swamp knows, the accumulation of organic matter is a characteristic feature of most wetland systems. A thick bed of organic matter is important for wetland health because it helps to even out fluctuations in soil temperature and water content that might otherwise stress wetland plants.

Bailey is tracking the health of his experimental plots using a combination of high-tech field gear and old-fashioned plant identification. His gear includes a transparent, airtight plastic chamber whose base is implanted in the wetland soil. The chamber is connected to a set of computerized data loggers that record levels of carbon dioxide (CO_2), light, photosynthesis, as well as air and soil temperature and other variables within the chamber.

At the same time, he monitors the number and types of plants growing in each plot, noting whether they are annuals or perennials, herbaceous or woody.

The CO_2 measurements will be particularly telling, says Bailey, as they provide a means to gauge whether the created wetland is beginning to function like its natural counterpart in terms of energy flow.

VIMS graduate students Azure Bevington (L) and David Bailey (R) monitor experimental plots within a created wetland in Charles City County.

Previous studies suggest that when natural plant communities first colonize a disturbed area, most of the incoming solar energy goes into photosynthesis and plant growth—allowing the system to soak up CO_2 from the atmosphere. As the community matures, succeeding generations of plants die, and carbon-rich organic materials accumulate. This pushes CO_2 in the opposite direction—from animal decomposers and soils back into the air. In a mature wetland, the system should be in equilibrium—CO_2 in equals CO_2 out.

Bailey's CO_2 sensors will allow him to gauge where the created wetland lies along this continuum from carbon "sink" to carbon source, a determination that has important implications both for global-warming scenarios and scientists' basic understanding of "primary succession" in wetlands.

Primary succession, the process by which a living community develops from scratch following a major ecological disturbance, has been studied extensively in other ecosystems, but rarely in wetlands, and even more rarely in created wetlands.

"We don't have any earthquakes and fewer volcanoes in Tidewater Virginia," says Perry, in reference to the ecological events that have preceded most previous incidents (and studies) of primary succession. "So our biggest challenge is that we have no models to learn from."

Created wetlands, because they are built on ground that has typically been scraped bare of plants, soil, and seeds, provide the model that Perry and other wetland ecologists have sought.

"We can learn a lot by using a created wetland as a model of primary succession," says Perry. " We can look at the new system, and the processes by which it matures from the herbaceous to the woody stage, and then use that scientific information to do better management."

Based on early studies of primary succession, Perry's group expected to see a sequential shift from annual plants to bushes and then larger trees in the created wetland, with the Chickahominy site someday maturing into a forested wetland dominated by river birch, pin oaks, and other moisture-tolerant trees—a process that can take decades.

But a 2004 study by Perry's former graduate student Dr. Doug DeBerry turned up a surprise—instead of being dominated by grasses or other annuals, almost half the wetland was clothed in native perennials like the tapertip rush. Perry and DeBerry attribute the discrepancy to wading birds carrying rush seeds from distant wetlands, and have now advised wetland managers to incorporate these native species in their plantings to help stabilize newly constructed wetlands in other areas of Tidewater Virginia.

"That's a really great thing about this work," says Perry. "We're doing basic science that has real meaning and value in an applied setting."

Bailey's final results are not yet in, but one thing he has discovered is that adding large amounts of mulch can be detrimental to wetland health—not because of any direct effect, but because by raising the ground surface the mulch makes the soil dry out more quickly and remain dry longer, thus allowing upland plants to invade.

Another Perry graduate student, Azure Bevington, is just starting her wetlands research, in which she aims to study the effects of cattails on wetland restoration. In some created wetlands, these native plants have taken over almost completely. Bevington wants to know why, and whether their dominance might be detrimental to other wetland plants and the process of succession.