15-year study: When it comes to creating wetlands, Mother Nature is in charge

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This is an a\Aerial view of the two experimental wetlands at Ohio State University in 1995. The planted wetland is on the right in the photos. Credit: Photos courtesy of Ohio State University

Fifteen years of studying two experimental wetlands has convinced Bill Mitsch that turning the reins over to Mother Nature makes the most sense when it comes to this area of ecological restoration.

Mitsch, an environment and natural resources professor at Ohio State University, has led the effort to compare the behavior of two experimental marshes on campus – one that was planted in 1994 with wetland vegetation and another that was left to colonize plant and animal life on its own.

The two wetlands now contain nearly the same number of plant species, and almost 100 more species than existed 15 years ago. When the two marshes were created, researchers planted 13 common wetland species in one marsh and left the other to develop naturally. Water from the nearby Olentangy River has been continually pumped into both marshes at rates designed to mimic water flow in a freshwater river wetland setting.

The wetlands' general similarities have persisted even after muskrats spent the winter of 2000-01 destroying most of the plants in both wetlands, either eating them or using them to build dens. Though the muskrats' favored cattails dominated the unplanted wetland at the time, bulrush grew back in the cattails' place as the marshes recovered from the animal damage. Trees also ring both wetlands, hinting at the possibility that the site could someday be transformed from a marsh into a forested wetland.

These developments suggest that as time passes, the initial conditions of the wetlands matter less than how they develop naturally on their own, Mitsch said.

"Both wetlands are examples of what we call self-design," he said. "Human beings can be involved in the beginning, but ultimately the system designs itself according to the laws of Mother Nature and Father Time." The analysis is published in the March issue of the journal *BioScience*.

Mitsch is a staunch proponent of factoring wetlands' contributions to carbon storage, or sequestration, into worldwide strategies to offset greenhouse gas emissions. This study and his other research on freshwater wetlands suggest to Mitsch that wetlands could provide substantial support in this area.

At the 15-year mark, the unplanted wetland's rate of carbon retention stood at 266 grams of carbon per square meter per year, compared to 219 grams in the planted wetland. Mitsch noted that these are considerably higher than are the carbon sequestration rates estimated at a natural reference wetland used for comparison: Old Woman Creek near Lake Erie. Carbon sequestration rates there range from 125 to 160 grams of carbon per square meter per year.

One significant difference seen between the planted and unplanted experimental wetlands, however, was their rates of methane emission. Mitsch and colleagues measured these emissions from 2004 to 2008. The unplanted wetland emitted about twice as much methane as did the planted wetland, releasing 32 grams and 16 grams of methane per square meter per year, respectively.

"The planted wetland remained a little more diverse in plant communities, and biodiversity is good. The unplanted wetland appeared to go for power, in the thermodynamic sense, and had more productivity and more plants," Mitsch said. "In the end, that's the one that had more carbon sequestration, but it also had more methane. So you get the yin and the yang of carbon with the unplanted wetland."

Almost all freshwater wetlands are known to release methane, a greenhouse gas, into the atmosphere, but Mitsch asserts that wetlands' role as carbon sinks more than compensates for the methane emissions. Methane oxidizes in the atmosphere while carbon dioxide does not, tipping the balance of value for protection against greenhouse gases in favor of wetlands because of their carbon storage capacity, he said.

These wetlands taught the scientists a number of lessons about wetland creation despite their small size. The 2 ½-acre marshes are part of Ohio State's Wilma H. Schiermeier Olentangy River Wetland Research Park, which Mitsch directs.

If the soil is any indication, its adaptation showed that one can create a wetland anywhere there is a constant source of water. The soil at the site, former farmland, became hydric – an indicator that a wetland exists – within just a few years.

The wetlands were a bit of a disappointment in the area of nutrient retention, which relates to a wetland's work to purify water.

Phosphorus is problematic in inland freshwater systems, where, in excess, it can stimulate the growth of algae. The experimental wetlands at Ohio State started strong at retaining phosphorus, but the retention rate has declined over time, from 60 percent to about 5 percent over the course of the 15 years of study.

For nitrates, which can lead to algae blooms and kill some fish species in coastal waters such as the Gulf of Mexico, the rate of retention in the wetlands decreased from the early years from almost 40 percent to 25 percent, but now appears to have leveled off.

"The nitrate is a pretty good story, but the phosphorous retention is a warning that you can't get phosphorous retention from these wetlands over a really long time. They become saturated," Mitsch said.

He noted that a common discussion in ecology circles these days is a reference to "ecosystem services," where scientists and policymakers are asking, 'What can nature do for humans?' In Mitsch's estimation, wetlands fulfill all expectations: They purify water by removing nitrogen and phosphorous, regulate the climate by storing carbon, retain flood waters and, in the case of coastal wetlands, protect coastal areas from hurricane damage, and enhance biodiversity, in effect serving as natural zoos and botanical gardens.

In economic terms, that means preservation of wetlands could translate into less investment needed for the construction of water treatment plants, flood control reservoirs and carbon sequestration technology, he said.

Something that remains unclear about wetland creation, however, is whether planting or allowing for natural colonization makes any difference in the long run. Of the 13 species planted at the beginning of the experiment in the planted wetland, nine remain there; in the unplanted basin, only two of those species are growing there at year 15. In the meantime, dozens of new species grew in each marsh.

"At the end of the day I'm not sure one wetland is more important than the other. There are positives for both," Mitsch said. "We just wanted to see for as long as we could what happens over time when you plant one wetland and don't plant the other. I think they're converging, tending to be similar."

Provided by Ohio State University

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