Planted, unplanted man-made wetlands are similar at year 15, and function as effective carbon sinks

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A 15-year experiment in an outdoor "laboratory" on Ohio State University's campus shows that naturally colonizing wetlands can offer just as many, if not more, ecological services as will wetlands planted by humans.

Researchers at Ohio State have been comparing the behavior of two experimental marshes on the 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 2 1/2-acre marshes are part of the Wilma H. Schiermeier Olentangy River Wetland Research Park, a 30-acre complex that functions as a "living laboratory" in ecological science.

After year 15, the two wetlands contained nearly the same number of plant species, and their rates of retaining phosphorus and nitrates - nutrients that can become potential water contaminants - were almost identical. Both wetlands also hold carbon in their soil, with this carbon sink function increasing steadily over the years.

Plant productivity and greenhouse gas emissions were two ways in which the wetlands differed at this stage in their lives: The naturally developing wetland produced more plant biomass and emits more of the greenhouse gas methane, the latter because it contains more decayed organic material from the higher biomass production. Bacteria that produce methane during that decaying process cause wetlands to release the gas into the atmosphere.

"These experimental wetlands have enabled us to start new ecosystems from scratch. You don't get to do that very often," said William Mitsch, an environment and natural resources professor at Ohio State and director of the wetland research park. "I consider these two wetlands after 15 years as standards. If people who create wetlands compare them to ours and find them to behave in the same way, then their wetlands are in pretty good shape."

Mitsch presented the 15-year wetland report Friday (8/6) at the annual meeting of the Ecological Society of America in Pittsburgh.

Often called the "kidneys" of the environment, wetlands act as buffer zones between land and waterways. In addition to absorbing carbon and holding onto it for years - a process called sequestration - wetlands filter out chemicals in water that runs off from farm fields, roads, parking lots and other surfaces.

When the two experimental wetlands were created in 1994, researchers planted 13 common wetland species in one marsh and left the other to develop as a natural wetland. Water from the nearby Olentangy River has been continually pumped into both marshes at rates to mimic water flow in a freshwater river wetland setting.

Within five years, both wetlands contained almost 100 different species each, and that plant diversity was maintained through the study period's end in 2008.

"I was surprised that the vegetation, the types of species and diversity of the plants, jumped up very fast, by year five," Mitsch said. By 1998, the planted wetland hosted 96 species and the naturally developing marsh was home to 87 species. Those numbers increased to 101 and 97 species, respectively, by 2008.

Seven dominant plant types were growing in year 15 in the created wetland: bur-reed, a variety of cattails, river bulrush and softstem bulrush, American lotus, sago pondweed and rice cutgrass. The three dominant plant types in the natural wetland at year 15 were the rice cutgrass, softstem bulrush and cattails.

"The naturally developing wetland was more powerful, the planted wetland still slightly more diverse," Mitsch said.

Even with that growth, Mitsch calls the wetlands "unfinished." He and his colleagues expect these two experimental marshes to be followed for a total of at least 50 years by university scientists of the future to tell the whole story of the similarities and differences between man-made and natural wetlands.

"I foresee that they will become more and more tree-like every year," Mitsch said. "We've got forest developing on the edges. We think they will be much more dominated by woody vegetation in 50 years."

The researchers have predicted that both wetlands' ability to sequester carbon in their soil will increase at a steady pace through year 50. At the 15-year mark, these two wetlands were sequestering carbon about 40 percent faster than was a similar reference natural wetland - 200 grams of carbon per square meter per year vs. 140 grams of carbon per square meter per year. This could be because of the high biomass production in the created wetlands, Mitsch said.

Though almost all freshwater wetlands are known to release methane, a greenhouse gas, into the atmosphere, Mitsch asserts that wetlands are valuable carbon dioxide sinks and that 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.

"I think wetlands' value as carbon sinks is gigantic, but it is still under-appreciated," Mitsch said. "This study and other work we've done suggests that wetlands can be cost-effective tools to reduce the effects of carbon emissions while they perform their other ecosystem functions, such as water quality improvement and flood control."

The Ohio State wetlands tell a different tale about their ability to retain nutrients, which helps prevent certain substances from fouling adjacent bodies of 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 10 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, the rate of retention in the wetlands has decreased some from the early years but remains consistent, from about 35 percent to 25 percent.

"In the long term, it looks like the wetland gets less effective at retaining phosphorus. For nitrates, it's different. That retention is controlled by microbes, and they are becoming stronger every year, so we expect the removal of nitrates to level off, or maybe even get better," Mitsch said.

Perhaps the greatest value of the wetland research park, Mitsch said, is that "It teaches us a lot about how nature does things."

Provided by The Ohio State University