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Collaborations, Research, and Adaptive Management to Address Nonnative *Phragmites australis* in the Great Lakes Basin

Phragmites australis, also known as common reed, is a native North American wetland grass that has grown in North America for thousands of years. More recently, a nonnative, invasive variety of Phragmites from Eurasia is rapidly invading wetlands across the continental United States and other parts of North America, where it negatively impacts humans and the environment. U.S. Geological Survey scientists, funded by the Great Lakes Restoration Initiative, are leading innovative efforts to improve management of nonnative Phragmites in the Great Lakes Basin.

Great Lakes *Phragmites* Collaborative

The U.S. Geological Survey (USGS) teamed up with the Great Lakes Commission to establish and guide the Great Lakes *Phragmites* Collaborative (GLPC), a regional-scale partnership funded through the Great Lakes Restoration Initiative. The GLPC follows the principles of "collective impact" to improve collaboration among stakeholders and increase the effectiveness of nonnative *Phragmites* management and research.

The GLPC serves as a communication conduit via an interactive Web site, a webinar series, and social media outlets to do the following: (1) facilitate access to information, (2) encourage technology transfer, and (3) promote network building among resource managers. A 2015 survey of GLPC users found that 64 percent of applicable participants changed the way they managed nonnative *Phragmites* based on information from the GLPC, and 99 percent of survey participants found the GLPC valuable. In 2015, the Web site reached approximately 11,000 users from the United States and Canada. The GLPC is improving the efficiency and effectiveness of nonnative *Phragmites* management on a regional scale.

Phragmites Adaptive Management Framework

Management of nonnative *Phragmites* is often uncoordinated at a regional scale, and managers face uncertainty regarding treatment effectiveness. Scientists from the USGS are working as part of a core team to develop and implement the *Phragmites* Adaptive Management Framework (PAMF), which will shift the management strategy for this invasive species. PAMF will aid resource managers by targeting treatment uncertainty and resolving it through a transparent, learning-based management system. Involved resource managers will actively fine-tune this management strategy through regular collection of data and will receive specific, annual treatment support from state-and-transition models updated with monitoring data. With time, this approach will help develop best management practices for different landscape conditions.

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Innovative *Phragmites* Control Strategies

Scientists from the USGS and other organizations are exploring new strategies to control nonnative *Phragmites*. These and other innovative control strategies may be key to long-term sustainable management.

Microbial Symbiosis

Relationships between plants and microbes (symbioses) can enhance performance of certain plant species (fig. 1), increasing their ability to invade new areas. The USGS is leading efforts to further understand these relationships and leverage them to support invasive species management. An international, USGS-led team of 11 partners is addressing the broad research question "Can nonnative *Phragmites* management be improved by utilizing existing microbial relationships?" by breaking it down into more focused research questions being addressed by collaborating research experts. Early results from this collaborative approach include identification of fungal and bacterial microbes that are associated with nonnative *Phragmites*, including fungal and bacterial microbes that help this invasive plant grow in stressful environments. The research team is working to understand the roles of each associated microbe and explore ways to exploit microbial functions to develop new management treatments. This collaborative, like the Great Lakes *Phragmites* Collaborative, is based on the principles of collective impact and will potentially lead to innovative nonnative *Phragmites* treatments.

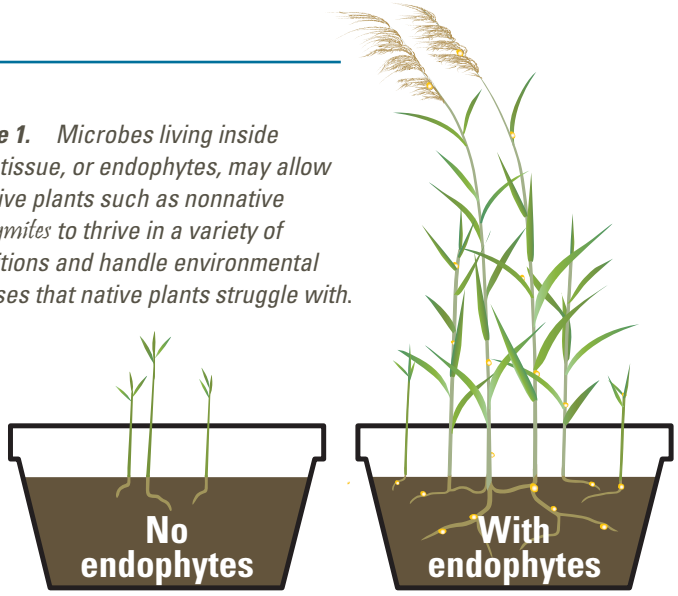

Figure 1. *Microbes living inside plant tissue, or endophytes, may allow invasive plants such as nonnative Phragmites to thrive in a variety of conditions and handle environmental stresses that native plants struggle with.*

Gene Silencing

What if land managers could treat nonnative *Phragmites* to reduce its growth while restoring native plant communities at the same time? Scientists at the USGS and Wayne State University are developing a strategy for restricting, or "silencing," the expression of plant genes that give nonnative *Phragmites* the traits that help them succeed when invading new areas. For example, if the genes necessary for photosynthesis are silenced, a plant may be unable to harness the Sun's energy, and growth would therefore be stunted. Studies on limiting the photosynthetic ability of similar plants (fig. 2) led to expanded testing of gene silencing techniques in nonnative *Phragmites*. The goal is to develop a species-specific management tool that limits the competitive advantage of nonnative *Phragmites* or other invasive plants without affecting native plants.

Figure 2. *A model plant species (maize) is shown with the genes that code for photosynthesis silenced (right), compared with a maize plant of the same age without gene silencing. Photograph by E. Golenberg (Wayne State University).*

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Great Lakes RESTORATION

Great Lakes PHRAGMITES COLLABORATIVE greatlakesphragmites.net