

The influence of environmental factors and nutrient availability on *Typha* spp. dominance in created wetlands

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Background and Objectives

Wetland creation is the process of converting a system that was previously upland or shallow water into a wetland (Mitsch and Gosselink 2000). Wetlands are created for a variety of purposes, including wastewater treatment, wildlife habitat, retention of drainage water, and most often to mitigate destruction of natural wetlands. The creation of mitigation wetlands is due, in part, to the permitting process that is required under section 404 of the Clean Water Act (CWA) (33 U.S.C. s/s 1251 et seq.). Section 404, passed in 1977, regulates dredge and fill activities in the nation's waters. In certain cases, such as in the construction of roads, wetland loss is determined to be unavoidable, and therefore, the destruction of natural wetlands must be mitigated by restoring or creating a wetland of the same type. However, it has been shown that wetlands created to fulfill the requirements of section 404, often fail to replace the function and structure of the wetland that was destroyed (Allen and Feddema 1996, Zedler 1996). This is a pressing concern because the regulations that are designed to limit the loss of wetland ecosystems may be facilitating the loss of many of the functions provided by wetlands, such as nutrient and sediment removal, flood remediation, and protection of habitat and biodiversity.

One of the most common causes of failure to replicate desired structure and function in created wetlands is invasion by undesirable nuisance plant species, such as *Typha* spp., *Phragmites australis* (Cav.) Trin. ex Steud., *Phalaris arundinacea* L. and *Lythrum salicaria* L. These species are considered to be invasive in both created and natural wetlands (Weihe and Neely 1997, Galatowitsch et al. 1999, Kercher and Zedler 2004, Zedler and Kercher 2004). The disturbances associated with wetland creation have been linked to invasion by *Typha* spp. and *P. australis* (Havens 1997, Moore et al. 1999, Woo and Zedler 2002). Both of these species are large, perennial herbs, that are able to reproduce very quickly by both clonal and propagule distribution. These traits allow them to effectively outcompete other colonizers and form dense monospecific stands in newly created wetlands.

For this research project, I will focus primarily on the occurrence of *Typha* spp. (cattails) in the vegetation community development of created palustrine forested wetlands and the environmental factors that may be correlated to the occurrence of dense monospecific stands of *Typha* spp. The sites I will be using were created by the Virginia Department of Transportation (VA DOT) to mitigate wetland loss due to highway construction and are all located in the Coastal Plain physiographic province of Virginia. I particularly want to investigate the role of soil biogeochemistry in the dominance of *Typha* spp. in these systems. The site managers and the Army Corps of Engineers, who approve the mitigation permits, consider dense stands of *Typha* spp. to indicate that the vegetation community has not replicated the structure of a natural system (pers. comm. VA Department of Transportation). The inability to achieve the desired plant community may indicate that there are other aspects of the site design that are not functionally correct. The common management response to a monoculture of *Typha* spp. or *P. australis* is cutting and/or spraying the site with herbicide. While this does change the

structure of the vegetation community for a period of time after treatment, the nuisance vegetation often comes back and dominates the system within a few years after it was eradicated (pers. comm. VA Department of Transportation). Removal of the vegetation does not address the underlying problem, that these sites may not have the correct soil and biogeochemical environment to support the desired vegetation community. Investigating the environmental conditions and competitive adaptations that facilitate *Typha* spp. invasion into created wetlands, particularly the relationships between the time since construction, nutrient availability, and nutrient uptake, will help to shed light on how the vegetation structure in created wetlands develops. Invasiveness has been observed for multiple species in the family Typhaceae (Thieret and Luken 1996) however, this project will focus only on the three species most common in the Coastal Plain region of Virginia: *Typha latifolia* L., *Typha angustifolia* L., and the hybrid between the two, *Typha x glauca* Godr. (Harvill Jr et al. 1992). The overall objective of this study is to describe how nutrient availability, elevation, and soil organic matter composition influence the dominance of *Typha* spp. and the successional development of created palustrine forested wetlands.

Methods

This study will be conducted in two recently created, early successional, wetlands (<5 years since construction) and two older, later successional, wetlands (>10 years since construction). Two stands within each wetland will be sampled; one stand dominated by *Typha* spp. (T) and one stand not dominated by *Typha* spp. (NT). Dominance is defined as greater than 20% cover, according to the 50/20 rule (Environmental Laboratory 1987). Sampling will occur in three 1 m² quadrats at random distances along and from a predetermined transect in each stand. The sites will be sampled monthly, from April to September, 2007. Sampling in both T and NT stands will include vegetation percent cover, water depth, and soil samples for nutrient availability and organic matter analyses. The soil samples will be collected using a 2 cm diameter corer, to a depth of 20 cm, and will be separated into 0 to 10 cm and 10 to 20 cm sub-samples for analyses. *Typha* spp. leaves will be collected from the T stands to measure C:N:P ratios in the leaf tissue. The number of live, dead, and flowering *Typha* spp. shoots will also be counted in the T stands. Porewater will be sampled on a bimonthly basis at all the sites using diffusion samplers that will be allowed to equilibrate *in situ* for 3 weeks (Hesslein 1976). Two diffusion samplers will be deployed in each stand at each site. Because all three species of *Typha* have been observed at the study sites, I will survey the sites in June (period of peak flowering) to determine the proportion of each species present at each site. Percent cover, soil and *Typha* spp. leaf samples were collected during the summer of 2006, and this data will be added to the data collected in the 2007 growing season.

I will use principle components analysis to determine significant relationships between the environmental factors (soil and pore water nutrient availability, soil organic matter content, and elevation) and occurrence of *Typha* spp. I will also create a preliminary model of nutrient flows for the *Typha* spp. dominated stands in the newer (early successional) sites and older (later successional) sites. The model will include nutrient pools in the plant tissue, soil, and porewater, as well as nutrient fluxes, including remineralization, translocation, and plant growth. The model will not address nutrient fluxes due to drainage or evapotranspiration. I will compare the sizes of available pools and fluxes between older and newer sites to determine if there are significant differences

in nutrient availability and utilization by *Typha* spp. in created wetland sites of different ages.

Significance to Wetland Conservation

Despite the problems with wetland creation, it is a practice that is becoming more and more common and will continue to be used in the future. Therefore, it is especially important to learn as much as possible about what is controlling the successional development of these sites, and the biogeochemical processes taking place in the soil. By determining the role of biogeochemistry in controlling the vegetation community that persists in created wetlands, I hope to provide much needed information about created wetland functioning and development. Only with increased knowledge of how these sites develop, will managers be able to design and manage sites that will mature into functional wetlands.

I hope that through this research I will be able to highlight some of the strengths and weakness of the created sites I am working in, and determine what factors may be the most likely to correlate to the failure of these systems to meet the goals set out for vegetation structure. Until there is a better understanding of how these sites mature and function, the widespread use of created wetlands is likely to end up in a net loss of functional wetlands. This will compound the extreme losses that occurred in the 20th century. As human populations increase, the need for the services provide by wetlands, such as flood protection, groundwater recharge, and water purification, will also increase. At the same time, the number of functional wetlands able to perform these services will continue to decline. The declaration of President George H.W. Bush of 'No Net Loss' of wetlands can only become a reality if we are able to better understand the processes that are at work in natural systems and devise ways to replicate them in created systems. The way to do this is to apply our knowledge of natural systems to studying created wetlands and analyze the entire ecosystem to determine how it develops over time.

Personal Statement

I have always been fascinated by anywhere that is wet and muddy. I grew up in La Crosse, Wisconsin, an area of extensive Mississippi River floodplains, and often spent time at parks and natural areas that were located along and near marshes. Growing up in an area that provided many opportunities for hands-on nature education provided me with the wonder and enthusiasm to study science, and especially ecology. As an undergraduate at Coastal Carolina University, I worked extensively in the salt marsh and nearshore ecosystems along the coast of South Carolina, and learned about the deleterious effects of development on coastal wetlands and water quality. I am now enjoying being able to learn more about both non-tidal and tidal wetlands in the Chesapeake Bay watershed. In the future, I would like to work at an environmental advocacy organization helping to strengthen protections for remaining wetlands. I think that an important step in strengthening laws that support conservation of wetlands, and many other types of ecosystems, is to have a public that cares about these resources and understands their importance. Because of this, I am especially interested in working in community outreach and education; where I would like to develop strong citizen support and understanding for the importance of wetlands in our daily life, not only as providers of services such as water purification, but also as areas of amazing and diverse natural beauty that have an intrinsic right to be protected for future generations.

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