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RESEARCH ARTICLE

Plant and Soil Responses to Created Microtopography and Soil Treatments in Bottomland Hardwood Forest Restoration

Matthew E. Simmons,[1,2] X. Ben Wu,[1] and Steven G. Whisenant[1]

Abstract

Although microtopographic heterogeneity is common in bottomland hardwood forests, it is rarely considered in bottomland restoration efforts. The objective of this study was to determine the responses of hydrologic condition, soil physiochemical properties, and introduced and colonizing vegetation to created microtopography and soil treatments at a landfill borrow pit in northern Texas. A series of mounds and pools were created and planted with fast-growing pioneer species as well as more desirable, later-successional species. Erosion control mats were installed on half the plots as a source of organic matter. Erosion control mats had little influence on introduced seedling survival or colonizing species abundance, but microtopography strongly influenced hydrologic condition, soil properties, seedling survival and growth, and colonizing species abundance and distribution. Pools were flooded during much of the summer months and had significantly higher nitrate and total nitrogen concentrations than mounds. Topographic position had little effect on survival of pioneer species, but mortality of most later-successional species was highest in pools. Colonizing species distribution and abundance were also strongly related to topographic position. Despite differences in soil nutrient concentration among topographic zones, hydrologic condition likely had the strongest influence on growth and survival of planted species and distribution of colonizing species. Creating microtopography resulted in a spatially heterogeneous system that reflected variations in natural bottomlands, and introducing a mix of species (pioneer and later-successional) across topographic and hydrologic gradients may improve the establishment and survival of a diverse community when hydrologic condition is highly variable or difficult to predict.

Key words: borrow pit, erosion control mat, hydrology, soil properties, spatial heterogeneity, wetland.

Introduction

Topographic heterogeneity has long been recognized as an important component of bottomland hardwood forests (Oosting 1942; Wikum & Wali 1974; Buchholz 1981; Hardin & Wistendahl 1983), and spatial heterogeneity is thought to promote diverse communities (Huston 1994). Small-scale microtopographic heterogeneity, on the order of decimeters or less, influences community structure directly and indirectly through various mechanisms, including differential seedling recruitment along hydrologic gradients (Keddy & Ellis 1984), variation in litter accumulation (Todd et al. 2000), differences in plant establishment and mortality due to microsite characteristics (Eldridge et al. 1991), and variation in biogeochemical cycling in response to flooding regimes (Darke & Walbridge 2000). Microtopographic heterogeneity in bottomland forests is often created through disturbances such as tree fall, sediment accumulation, erosion following flooding, and animal activities (Ehrenfeld 1995).

Although microtopographic variation is an important and natural part of bottomland hardwood forests, the creation of microtopographic heterogeneity during restoration efforts has been largely absent (Stolt et al. 2000), perhaps due in part to the significant costs incurred in contouring large areas. However, incorporating microtopography into wetland restorations may create the edaphic and hydrologic variations essential for the colonization, establishment, and survival of a diverse community (Beatty 1984; Todd et al. 2000), thereby accelerating the development of wetland species composition and function (Bruland & Richardson 2005).

Conversely, a frequent goal of bottomland forest restoration is to quickly develop a woody canopy to support wildlife, which is commonly attempted by introducing desirable, later-successional, hard mast-producing seedlings (King & Keeland 1999). However, high seedling mortality often results due to poor suitability of introduced species to site conditions (Whittecar & Daniels 1999; Patterson & Adams 2003). As hydrologic condition is the most important factor regulating wetland ecology, species selected should be adapted to hydrologic regimes encountered at the site. It is well known that

[1] Department of Ecosystem Science and Management, Texas A&M University, 2138 TAMU, College Station, TX 77843, U.S.A.
[2] Address correspondence to M. E. Simmons email msimmons@ibcas.ac.cn

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