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Influence of tree shelters on seedling success in an afforested riparian zone

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Abstract The restoration of a natural riparian ecosystem is a key component to improving water quality and restoring stream health in a disturbed watershed. The rate and degree of riparian restoration, and hence stream restoration, depends in part upon afforestation practices. Successful afforestation is determined largely by the rates of survivorship and growth of the tree species planted or recruited in a riparian zone. This study was part of a project involving the restoration of a channelized section of Wilson Creek located in the Bernheim Arboretum and Research Forest, Nelson County, Kentucky. Riparian restoration activities focused on reestablishing a native riparian corridor using American sycamore (*Platanus occidentalis*), green ash (*Fraxinus pennsylvanica* var. *subintegerrima*), and pin oak (*Quercus palustris*). This study evaluated techniques for improving the growth and survivorship of planted seedlings along Wilson Creek. Specifically, two tree shelter types (Tubex® vs. continental mesh), with or without herbicide treatments, were compared. Additionally, the influence of these techniques on debris retention within the riparian zone was also examined. Results showed that use of tree shelters significantly increased the growth of seedlings (but not survivorship), provided physical protection especially during heavy flooding events, and accelerated woody debris retention. Both Tubex® and continental mesh tree shelters were effective in enhancing seedling growth, with Tubex® shelters yielding significantly better growth when combined with herbicide to control competing vegetation. Thus, the most cost effective choice may

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depend on the environmental setting and ability to combine the shelters with other growth enhancing treatments.

Keywords Riparian restoration · Tree shelters · Seedling growth · Debris accumulation

Introduction

Stream restoration is a widely accepted best management practice and, as of late, an emerging business enterprise. In the United States alone, billions of dollars have been spent on stream and river restoration (Palmer et al. 2005). A key aspect of restoring stream health is the successful restoration of its adjacent riparian ecosystem (Goodwin et al. 1997). Riparian ecosystems are intimately connected to the stream channel, and exhibit high biotic, structural, and functional diversity (Naiman and Décamps 1997).

In small streams, riparian vegetation affects aquatic food webs directly through leaf litter and dissolved organic carbon inputs, and indirectly through its influence on factors that affect algal production such as light and temperature (Opperman and Merenlender 2000; Correll 2005). Riparian vegetation also affects the population and community structure of primary consumer organisms such as bacteria, invertebrates, and fish by maintaining summer temperatures at levels low enough for survival of cold—water species (Peterjohn and Correll 1984; Wissmar and Beschta 1998; Opperman and Merenlender 2000), while providing a good supply of coarse woody debris (CWD) to maintain channel structure and habitat (Peterjohn and Correll 1984; Naiman and Décamps 1997; Wissmar and Beschta 1998; Correll 2005).

Even though restoration of riparian ecosystems improves water and habitat quality of streams, it can be a slow and difficult process (Sweeney et al. 2002). The rate and degree of riparian restoration, and its ability to improve stream ecosystem function and water quality depends, in part, upon afforestation practices. Afforestation success is often gauged by the survivorship and growth of plants used in the restoration as well as the level of natural diversity in the final canopy (Sweeney and Czapka 2004).

Although the science of riparian restoration is young and not well understood (Goodwin et al. 1997), several techniques have been developed in recent years to improve the growth and survival of forested species in riparian areas. Tree shelters have been used to protect seedlings from herbivory (Lantagne 1989; Sweeney 1992; Stange and Shea 1998; Gerhold 1999; West et al. 1999; Conner et al. 2000; Sweeney et al. 2002), and herbicides have been used to reduce competition from invasive and regenerative species (Dubois et al. 2000; Sweeney et al. 2002).

Tubex® tree shelters, first used by Graham Tuley in Great Britain, are plastic tubes placed over seedlings to protect them from browsing, and to provide a microenvironment (“greenhouse effect”) to enhance growth (Tuley 1983, 1985). Although they have shown their usefulness in many studies (Lantagne 1989; Allen 1994; Stange and Shea 1998; Gerhold 1999; West et al. 1999; Conner et al. 2000; Dubois et al. 2000; DuPlissis et al. 2000; Opperman and Merenlender 2000; Sweeney et al. 2002), one main drawback of Tubex® shelters is their cost. The purchase and installation of these shelters can cost significantly more than the seedling itself. Although shelters have been developed that are more cost efficient, research on their performance under field conditions is limited.

This study was part of a project involving the reestablishment of a native riparian forest along a channelized section of Wilson Creek (Nelson County, Kentucky), which was being returned to its original meandering configuration. Restoration activities were focused on a