RESTORING BOTTOMLAND HARDWOOD FORESTS: A COMPARISON OF FOUR TECHNIQUES

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Introduction

Large-scale afforestation of former agricultural lands in the Lower Mississippi Alluvial Valley (LMAV) is one of the largest forest restoration efforts in the world and continues to attract interest from landowners, policy makers, scientists, and managers. The decision by many landowners to afforest these lands has been aided in part by the increased availability of public and private incentive programs such as the Wetlands Reserve Program (WRP). The WRP provides a landowner with a one-time easement payment, technical expertise, and reimbursement for part or all of the afforestation costs. Large-scale afforestation is occurring on thousands of hectares in the LMAV (King and Keeland 1999; Stanturf et al. 2000; Schoenholtz et al. 2001).

Early results from the WRP were discouraging (Stanturf et al. 2001a); seedling and acorn survival rates were low, despite much available information on planting and direct seeding techniques (Stanturf et al. 1998). Although the basic techniques for afforesting native hardwood species have been worked out, few studies compared several techniques on the same site. In response to questions from managers, we undertook a study to compare operational techniques for afforesting bottomland hardwoods. In addition to standard approaches of planting bare-root seedlings and direct seeding acorns, we included an interplanting technique using a fast-growing, native species (*Populus deltoides* Bartr. ex Marsh.) with an oak species (*Quercus nuttallii* Palmer) and another treatment of doing nothing and depending upon natural invasion. The specific objectives of the study were to demonstrate and compare four restoration techniques in terms of survival, accretion of vertical structure, and species diversity.

Methodology

The study was located in Sharkey County, MS (N32°58' W90°44'), in the Yazoo River Basin. The land was actively cropped until the study was established. The hydrologic and edaphic conditions of the study site were typical of land available for restoration in LMAV. Soils were mapped as the Sharkey series of very-fine, smectitic, thermic chromic Epiaquerts. Sharkey soils consist of poorly drained clays formed in fine textured sediment in slack water areas in the Mississippi River floodplain. The shrink-swell nature of Vertisols results in 2 to 10 cm wide cracks up to 1.5 m deep that form under dry conditions, and close when saturated.

The experiment was a randomized complete block design with three replicates located in different portions of the tract. Treatment plots were 8.1 ha and approximately rectangular. Treatments were chosen to represent a gradient in restoration intensity, from natural invasion, direct seeding Nuttall oak, planting Nuttall oak, to interplanting eastern cottonwood with Nuttall oak. The natural invasion treatment was the baseline to compare passive versus active restoration. Direct seeding and planting bareroot seedlings are routinely used restoration techniques in the LMAV under federal incentive programs (Stanturf et al. 2000). The interplanting technique combines a fast growing species, eastern cottonwood, as a nurse crop for the slower growing oak. The cottonwood can be harvested in as little as 10 years, providing a financial return to the landowner (Stanturf and Portwood 1999).

Direct seeding and planting treatments were installed in February 1995 and the cottonwood was planted in the interplanting treatment in March 1995. Acorns for the direct seeding treatment were collected from nearby natural stands, placed in water and non-viable acorns that floated were discarded. Acorns were stored in ventilated polyethylene bags at 1.7 °C until sowing. Acorns were machine sown by Fish and Wildlife Service staff in May 1995. Spacing was 1.1 m by 3.7 m, with one acorn placed at each planting spot. Bareroot 1-0 Nuttall oak seedlings were obtained from a commercial nursery. Oak seedlings were machine planted by Fish and Wildlife Service staff in March 1995 at 3.7 m by 3.7 m spacing.

Eastern cottonwood cuttings were hand planted according to procedures used operationally by forest industry (Stanturf et al. 2001b). Four commercially available clones were planted at 3.7 m by 3.7 m spacing. Three clones had been selected from native populations along the Mississippi River (ST66, ST72, ST75) and one was from an east Texas population (S7C1); all four clones are used operationally. Clonal material was provided by Crown Vantage (now Tembek) and grown in their nursery at Fitler, MS. Two growing seasons later (March 1997), Nuttall oak seedlings were interplanted under the cottonwood. Oaks were planted between every other cottonwood row so the cottonwood can be harvested without damage to the oaks. Spacing for these oak seedlings was 3.7 m by 7.4 m.

Four permanent measurement plots were installed in each treatment plot in autumn 1995. Survival, height and diameter growth were measured in the active restoration treatments annually through the fifth growing season. Height and diameter data were collected for all woody stems in the natural invasion treatment annually beginning with the second growing season. The interplanted oak seedlings, planted after the second growing season of the overstory, were measured annually.

Results and Discussion

There were no significant differences in soil chemical properties at any depth between the four restoration treatments. Soil bulk density was not significantly different for the treatments, although there were significant differences between blocks. After five growing seasons, the cottonwoods were the tallest trees and had the greatest density. Height of planted oaks averaged almost 1.4 m and was significantly taller than the direct seeded and interplanted oaks, which did not differ. Even though the direct-seeded oaks had been growing on the site two years longer than the interplanted oaks, they were not significantly taller. The direct-seeded oaks had greater diameter than the interplanted and they accumulated more biomass

The abandoned soybean field was invaded over time by woody species disseminated by wind and by birds. Swamp dogwood *(Cornus stricta),* common persimmon *(Diospyros virginiana)*, green ash *(Fraxinus pennsylvanica)*, sugarberry *(Celtis laevigata)*, American elm *(Ulmus Americana),* hawthorns (Craetaegus species), cedar elm *(Ulmus crassifolia)*, honeylocust *(Gleditsia triacanthos)*, and deciduous holly *(Ilex decidua)* were the woody species found in the measurement plots.

This project was designed to test one alternative afforestation technique that combines a faster growing species with a slower growing species and to contrast this technique with more traditional approaches of planting bareroot seedlings or direct seeding of acorns. The control treatment for this study is to do nothing and allow natural invasion to occur. The early growth of cottonwood allowed for the rapid establishment of a forest canopy. The advantage of this canopy is that it may lend itself to accelerating natural succession by attracting birds and small mammals that are vectors for dispersal of heavy seed. The major disadvantage of pure cottonwood plantations to wildlife may be the paucity of hard mast. Although some may also feel that the intensive cultivation needed to establish cottonwood works against restoration goals, other studies have found that wildlife importance values for all wildlife food plants in cottonwood plantations studied peaked in the fourth, fifth and sixth growing season. The interplanting scheme under study here will provide for hard mast; once cultivation ceases after establishment, other herbaceous plants will establish.

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