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Restoration of Understory Trees on Bottomland Hardwood Sites (Mississippi)

James A. Allen, Paul Smith's College, Box 265, Paul Smiths, NY 12970; Jon Wessman, U. S. Fish & Wildlife Service, 1500 Museum Road, Suite 105, Conway, AR 72032; and Daniel J. Twedt (corresponding author), USGS Patuxent Wildlife Research Center, 2524 South Frontage Road, Vicksburg, MS 39180, 601/629-6605, Fax: 601/636-9541, dan_twedt@usgs.gov

Efforts to restore bottomland forests in the Mississippi Alluvial Valley have emphasized planting heavy seeded canopy trees, such as oaks (*Quercus* spp.), with the expectation that other species would naturally colonize these sites (King and Keeland 1999). Although it has been assumed that this strategy will result in diverse forests, isolation of many of these sites and on-site allelopathic conditions often limit colonization by woody species (Allen 1997, Twedt 2004). As a result, some maturing restored forests have little species diversity and a relatively homogeneous structure that inhibits colonization by wildlife, particularly forest-dependent birds (Twedt and Wilson 2002, Twedt and others 2002). Wildlife benefit from the spatial and temporal distribution of food and shelter resources. In particular, the seasonality of species-specific fruit production provides complex and continuous food resources. However, reforested sites often lack trees and shrubs that produce the soft, fleshy fruits favored by songbirds. In the study we report on here, we sought to provide additional fruit-bearing understory trees by planting seedlings.

In March 1990, we planted 25 one-year-old, bare-root mayhaw (*Crataegus aestivalis*) seedlings on each of three sites at Yazoo National Wildlife Refuge in west-central Mississippi. Mayhaws produce fruits that are widely consumed by wildlife and, unlike many other understory species, seedlings are commercially available. The three planted sites represented different stages in the development of restored forests: 1) an open field, 2) a stand of 16.4-ft (5-m) tall water and willow oaks (*Quercus nigra* and *Q. phellos*) planted in 1982, and 3) a mature, natural bottomland hardwood forest. We recorded initial heights of planted mayhaw seedlings and assessed their survival and growth in February 1991 and 1992, and November 2005.

More than 80 percent of the seedlings survived after the first year, but exhibited little increase in height (Table 1). Browsed and clipped stems may have limited mayhaw growth, since unbrowsed seedlings grew substantially taller during the first year (Table 1). Following our first-year evaluation, we protected 15 seedlings on each site using ten 1.9-ft (0.6-m) and five 3.9-ft (1.2-m) tall tree shelters (Tubex Ltd., www.tubex.com). However, shelters did not markedly improve seedling growth during their second growing season (Table 1).

After 15 growing seasons, 13 trees survived in the open field, whereas only two survived on each of the other sites (Table 1). Ten of 13 surviving mayhaws within the open field exceeded 15 ft (4.5 m) in height with a mean basal diameter of 4 inches (10 cm). Although now overtopped by other invading tree species, open grown mayhaw trees were well established and likely producing fruit. On the reforested and mature forest sites, the most robust surviving sapling was 9.8-ft (3-m) tall with a basal diameter of 0.8 inches (2 cm). The growth form and condition of these surviving saplings suggested that little or no mayhaw fruit production was occurring on reforested and mature forest sites.

Our results indicate that long-term survival and growth of mayhaw was poor when planted in mature bottomland forest and in eight-year-old reforested stands. Fifteen years after mayhaws were planted, both of these stands had dense overstory canopies and sparse understory vegetation. As mayhaws require full or partial sun (Gilman and Watson 1993), lack of sunlight to the forest understory likely contributed to the demise of the seedlings. Conversely, mayhaws planted in an open field had comparatively good survival and growth. Given the poor long-term survival of saplings subjected to low light conditions, we recommend including mayhaw seedlings as part of the initial planting during bottomland forest restoration. Alternatively, this species could also be planted in openings or gaps that are intentionally left unplanted during the initial restoration (Allen 1997), or more shade-tolerant species of understory trees or shrubs could be planted.

Table 1. Tree height [cm ± se] and survival (n) of 25 mayhaw (*Crataegus aestivalis*) seedlings planted in an open field, an eight-year-old reforested site, and a mature bottomland hardwood forest on Yazoo National Wildlife Refuge, west-central Mississippi during 1990.

	Initial	One year	Unbrowsed after one year	Two years	Tree shelters after two years	15 years
Open	27.4 ±1.0 (25)	28.9 ±3.0 (20)	33.6 ±0.8 (13)	40.0 ±4.6 (19)	41.2 ± 5.9 (14)	466 ±44 (13)*
Reforested	27.8 ±1.8 (25)	29.2 ±3.6 (25)	42.3 ±3.8 (11)	43.4 ±3.9 (24)	47.4 ±5.8 (15)	249 ±51 (2)
Mature	24.2 ±1.1 (25)	22.7 ±2.3 (23)	32.8 ±2.8 (8)	27.3 ±3.3 (11)	27.4 ±6.9 (5)	193 ±10 (2)

*Eleven surviving trees in the open field were associated with tree tubes.

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Vinal Forest Restoration Contributes to Sustainable Rural Development (Argentina)

Carlos Blasco, Elizabeth Astrada and Sebastián Carenzo, Grupo de Estudios sobre Ecología Regional (GESER), Facultad de Ciencias Exactas y Naturales, University of Buenos Aires, Buenos Aires, Argentina; and Alejandro Rescia (corresponding author), Ecology Dept., Biology Faculty, Complutense University of Madrid, Spain, alejo296@bio.ucm.es

A combination of flooding and fire in Argentina's semi-arid Chaco region once maintained a savanna-like landscape of pasturelands mixed with patches of hardwood species (Adámoli and others 1990). During the last century, overgrazing by cattle and a long period of lower-than-average rainfall led to rapid encroachment of vinal or mesquite (*Prosopis ruscifolia*), a native woody species that has little resistance to fire (Cabral and others 2003). Sites infested with dense stands of vinal have low biodiversity and are generally considered to be unproductive. Efforts during the 1970s to eradicate vinal met with varying degrees of success. However, they did not address the reasons for the plant's invasiveness, were costly, and posed risks to environmental and human health.

Given the persistence of vinal, the excellent characteristics of its wood and its value as a nitrogen-fixing species, we are including it in recovery models of native forest production that favor the growth of the best individuals and include multiple uses (pasture soil improvement, timber and non-timber materials, beekeeping, and fruit production). In this note, we discuss the economic feasibility of a model for vinal grove production that researchers from the Grupo de Estudios sobre Ecología Regional (GESER) began developing in 1998. The approach we describe is derived from trials that we conducted in Formosa province and the experience of 60 peasant families who are applying the model to degraded forests on small landholdings.

The model's management area is comprised of ten 7.4-acre (3-ha) plots—the optimum area that can be worked by an average family without neglecting other activities—that are actively managed during a 20-year period. During the first five years, landowners mechanically thin and prune vinal and all other woody species to about 50 percent of the original forest canopy. The goal is to improve forest structure and health, and to increase the abundance and diversity of herbaceous and woody species by reducing shade. In addition, cattle are excluded to enable recovery of understory species and the regeneration of woody species of interest, such as quebrachos (*Aspidosperma* and *Prosopis* spp.) and algarrobos (*Prosopis* spp.).

Using data from our study, we project that the quality of the timber to improve from primarily firewood grade (80 percent) during the first years to construction grade (60 percent) after 16 years. We also expect that restoration activities will improve livestock management in the restored pastures, while enclosures will triple the production of plant biomass. Two years after thinning, fruits from vinal and Argentine mesquite (*Prosopis alba*) may be harvested for animal feed and human consumption. After three years, the presence of flowering plants enables landowners to install beehives for honey and its derivative products.

Implementing this model requires initial investments during the first few years (primarily for chainsaws, fencing wire, and pasture seeds), and maintenance costs during the following years (Figure 1). During the first two years, these initial investments will result in an income deficit, but eventually generate rapid financial returns. After the fourth year, production from the restored forest should yield a monthly income of $530 Argentine pesos ($1 U.S. = 3 pesos). This is equivalent to income earned through more-widespread agricultural enterprises, such as cattle and cotton farming, and from outside sources, including day-labor jobs and

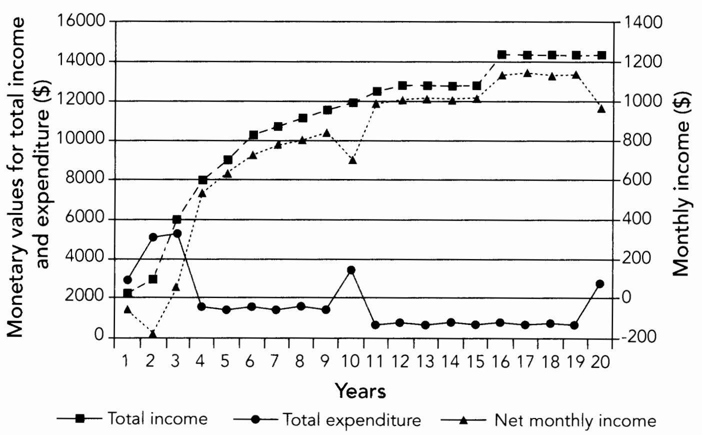

Figure 1. Projected 20-year economic evolution, expressed in Argentine pesos, of the sustainable vinal (*Prosopis ruscifolia*) forest restoration approach ($1 U.S. = $3 pesos).