Restoration of Oaks and Hickories in the Blackland Prairie Investigating Causality of Planting Failures/Successes

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INTRODUCTION

The ecotone between the Post Oak Savannah and the Blackland Prairie in Texas offers unique challenges to forest management. Vertic soils, frequent summer droughts, and prolonged winter flooding combine to make regenerating hardwood forests difficult. Oaks and hickories are currently found only in small pockets in this region.

Richland Creek Wildlife Management Area (RCWMA), which lies in this region (Figure 1), is currently dominated by cedar elm (*Ulmus crassifolia*), green ash (*Fraxinus pennsylvanica*), and sugarberry *(Celtis laevigata*), none of which produce significant mast for wildlife. Establishment of heavy mast-producing species is desirable to increase habitat diversity and restore ecological functions to these bottomlands.

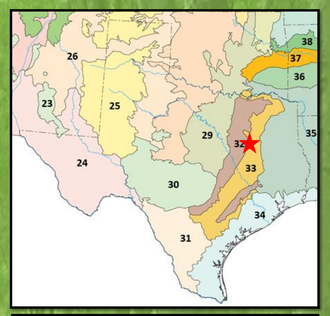

Figure 1. Map of ecoregions in Texas. Texas Blackland prairie is 32. Post oak savannah is 33. The red star represents the location of RCWMA.

Figure 2. Satellite image showing 3 study sites at RCWMA in red.

OBJECTIVES & HYPOTHESES

Objectives

- Test silvicultural methods (canopy reduction, competition control, and species selection) for the restoration of native oak and hickory species to identify the most effective combination of treatments to successfully regenerate and restore bottomland hardwood forests with heavy mast-producing species.
- Determine causality of planting failure or success.

Hypotheses

- Mulching will not affect seedling growth or survival.
- Controlling competing vegetation using spot application of herbicides will not affect seedling growth or survival.
- Species selection will not affect seedling growth or survival.

STUDY AREA

The Richland Creek Wildlife Management Area southern unit is 9,029 acres of mostly bottomland hardwood forests. RCWMA receives annual precipitation of 40 inches, although much of this is unavailable to plants due to the high percentage of clays in the vertic soils. Richland Creek and the Trinity River form the northern boundary, and all study sites are in the floodplain of one or both streams (Figure 2). Backwater flooding from these streams in winter and early spring is common. The study was replicated on three sites at the RCWMA. The easternmost site is adjacent to the Trinity River on the river levee (Figure 2). The middle site is located in the backswamp, and the westernmost site is located in a transition zone between bottomland and uplands (Figure 2).

METHODS

Experimental Design:

- A split-split plot experimental design was installed, with the whole plot replicated across three sites, and the split plot replicated in three blocks per whole plot.
- Whole plot: Mulched (50% basal area reduction from below) vs. untreated control
- Split plot: Glyphosate spot application vs. untreated control
- Split-split plot: Bur oak, Shumard oak, and pecan, with 20 observational units each

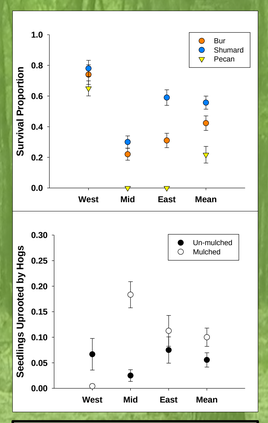

Figure 3. Top: Survival proportion by species across all 3 sites. **Bottom:** Uprooting by hogs according to level of mulching.

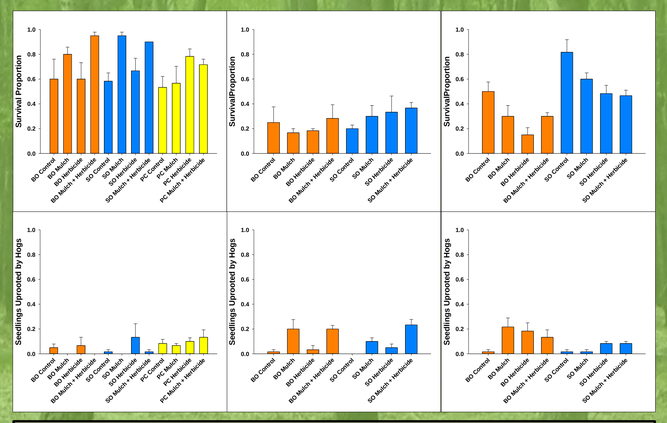

Figure 4. Left to right: West site, Middle site, East site. Top: Survival proportion. **Bottom:** Uprooting by hogs; BO=Bur Oak, SO=Shumard Oak, PC=Pecan.

Vertic soils cracking as soil dries.

Flooding from river. Arrow points to 8' fence post.

Planted seedling amongst herbaceous competition.

Seedling uprooted by hog.

RESULTS

Hogs entered the two easternmost sites shortly after planting and uprooted most of the pecan seedlings. Observational units had not yet been randomly selected, but mortality was so complete that the pecan seedlings had to be removed from the study for those two areas.

Shumard oak survival proportion was significantly higher than bur oak after one year (Figure 3, $p < 0.10$). Uprooting by hogs was significantly higher in the mulched treatments than in the un-mulched treatments (Figure 3, $p < 0.10$). Although the difference was small, this is believed to be a result of removing the surrounding vegetation, making the seedlings easier to find than they would be in undisturbed forest. Height growth for year one was significantly higher for bur oak than Shumard oak ($p < 0.10$).

DISCUSSION

The data suggest planting of Shumard oak yields highest survival proportion (Figure 3). Where hog predation was less, Shumard oak had the highest survival proportion (Figure 4). While the experiment was not designed to account for predation by wildlife, if each Shumard oak and bur oak seedling that was uprooted by hogs had survived, mean survival proportion would still be highest for Shumard oak. The significantly greater height growth by the bur oak seedlings was not enough after one growing season to give them an advantage over competing vegetation. If there are significant wildlife issues, some form of wildlife exclosure merits consideration, particularly if the seedlings are more visible due to canopy reduction treatments. Mixed species planting is recommended to minimize risks such as feral hog predation, leading to failure of one species.

The seedlings did not experience flooding into the growing season during the first year of the study. During the second year, the seedlings were under water well into the growing season. Survival counts for year two may also reflect differences in species due to a prolonged summer drought.

TIMELINE

- **December 2013:** All sites sampled to determine stand structure and composition
- **February 2014:** Mulching reduced basal area by 50% from below
- **March 2014:** Bareroot 1-0 seedlings planted on a 10x10 foot spacing (436 TPA)
- **May 2014:** Initial heights and basal diameters of all seedlings measured
- **May-June 2014:** Seedlings were covered and a 3x3 foot square around each seedling in the herbicide treatment was sprayed with glyphosate
- **February 2015:** Survival and growth were measured for year 1
- **December 2015:** Survival and growth will be measured for year 2

GREENHOUSE STUDY

A greenhouse study was established using seedlings of the same species planted in the main study. A randomized complete block design was used to evaluate each species' response to periods of inundation, followed by drought stressing to simulate the effects of seasonal weather patterns typical to the bottomland forests in the Blackland Prairie and Post Oak Savannah ecoregions. During the first phase of the experiment, half of the seedlings were flooded with water 4 inches above the soil, and the other half were a control that was watered regularly. During the second phase of the experiment, each half was divided into thirds. Each third then received either a flooded treatment, a drought treatment, or a control treatment.

Gas exchange and water relations were measured weekly using a LI-6400 infrared gas analyzer. Seedlings were harvested at the beginning and end of each phase of the experiment to measure root to shoot ratios and evaluate differences between biomass partitioning among the species. The pecan seedlings had greater photosynthetic rates on some dates in the control treatment (Figure 5). The Shumard seedlings in the flooding treatment dropped all their leaves before the first phase ended.

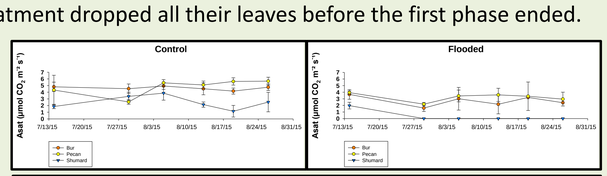

Figure 5. Photosynthetic rates for seedlings in flooded & control treatments in the greenhouse.

Left to right: Planted seedlings; Flagged seedlings for biomass partitioning harvest.

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