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Preliminary Results: Effects of Fertilization, Herbicide Application, and Prescribed Burning on Understory Regeneration on Pine Plantations in East Texas

Betsy Ott
Stephen F Austin State University

Brian Oswald
Stephen F Austin State University, boswald@sfasu.edu

Hans Williams
Stephen F Austin State University, hwilliams@sfasu.edu

Kenneth Farrish
Stephen F Austin State University, kfarrish@sfasu.edu

PRELIMINARY RESULTS: EFFECTS OF FERTILIZATION, HERBICIDE APPLICATION, AND PRESCRIBED BURNING ON UNDERSTORY REGENERATION ON PINE PLANTATIONS IN EAST TEXAS

Betsy Ott, Brian Oswald, Hans Williams, and Kenneth Farrish[1]

Abstract —Biodiversity and species rareness are increasingly the focal points for assessment of habitat quality. Managed pine plantations are often viewed as monocultures with little of value beyond their timber crop. The purpose of this study is to assess vegetative biodiversity in the understory of two pine plantations in which different vegetative control mechanisms are being evaluated. Controlled burn, herbicide treatment, and a combination of both are being compared on fertilized and unfertilized plots on two loblolly pine (*Pinus taeda*) plantations in east Texas. This study will compare species diversity and frequency on untreated and treated plots. One-square meter quadrat samples will be evaluated from 0.04 ha sampling plots within 0.1 ha treatment plots. Species richness will be determined as the number of species in each treatment plot. Shannon Index of Heterogeneity will be determined for each treatment. Comparison of different treatments will be made based on species richness and the Shannon diversity indices. Results for the first growth season after treatment will be presented.

INTRODUCTION

Preserving biodiversity has increasingly been recognized as an important management objective in both natural and planted stands (Carey and Curtis 1996; Franklin 1988, Hansen and others 1991; Roberts and Gilliam 1995). The Society of American Foresters recommends management of forestlands to “conserve, maintain, or enhance” biological diversity (SAF, 1991). Maintenance of biodiversity is a value often attributed to good forestry practice, at least on public lands.

Private land owners may become increasingly sensitive to the impact of silvicultural treatment on understory biodiversity as a consequence of increased public attention focused on this value. Limited studies have shown understory biodiversity in managed plantations to be comparable in some cases to that found in naturally reforested areas (Graee & Heskjaer 1997); other studies have shown reduced biodiversity (Hansen and others 1991). It is intuitively obvious that understory diversity will increase when deforested areas are planted in trees, even if the overstory is a monoculture (Lust and others 1998). Comparison of pine plantations to deforested areas would likely show greater biodiversity in the plantations. Further, the plasticity of crop trees such as *Pinus taeda* allows establishment on a variety of sites, which will show major differences in understory communities even though the overstory is homogeneous. Adding to the potential variability is the variation in canopy cover due to management processes such as thinning. In comparison to an undisturbed forest stand, a planted stand after row thinning can have considerably more light reaching the understory, creating more heterogeneity on the forest floor. Other management strategies could also affect understory biodiversity. Pine plantations thus are a potentially valuable natural resource in terms of vegetative biodiversity in the understory species.

This study was undertaken to determine the effect of treatments applied for the crop trees on the understory species richness, species diversity, and ground cover, as measures of biodiversity. Treatments included fertilization, prescribed burning, and herbicide application. The effect of applying herbicide was not analyzed after the first year.

MATERIALS AND METHODS

Field Setup

Two sites were selected in Cherokee County south of Alto, Texas, based on similarities in time of planting and thinning of loblolly pines. On each site, five replicates were established. Within each replicate, eight 0.10 ha treatments plots were set up with ten-meat buffer strips between treatment plots. Nested at the center of each treatment plot is a 0.04 ha measurement subplot.

[1]Ph.D. candidate, Associate Professors, Arthur Temple College of Forestry, Stephen F. Austin State University, Nacogdoches, Texas, respectively.

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TABLE 1— Species Lists for Cherokee Ridge and Sweet Union

Common Name	Scientific Name	Site(s)
FERNS		
royal fern	*Osmundia regalis*	CR
cinnamon fern	*Osmundia cinnamomea*	CR
brackenfern	*Pteridium aquilinum*	CR
FORBS		
common ragweed	*Ambrosia artemisifolia*	CR,SU
flowering spurge	*Euphorbia pubentissima*	CR,SU
yellow wood sorrel	*Oxalis stricta*	CR,SU
butterfly pea	*Centrosema virginianum*	CR,SU
black snakeroot	*Sanicula Canadensis*	CR
croton (goatweed)	*Croton capitatus*	CR
dewberry	*Rubus* spp.	SU
blackberry	*Rubus argutus*	CR,SU
dogfennell (cypressweed)	*Eupatorium capillifolium*	CR,SU
late boneset	*Eupatorium serotina*	CR,SU
selfheal	*Prunella vulgaris*	CR,SU
fleabane	*Erigeron strigosus*	CR,SU
partridge pea	*Chamaecrista fasciculate*	CR,SU
lyreleaf sage	*Salvia lyrata*	CR
American black nightshade	*Solanum americanum*	CR
butterfly milkweed	*Asclepias tuberosa*	CR
wild onion	*Allium canadense*	CR
skullcap	*Scutellaria integrifolia*	CR
bitter sneezeweed	*Helenium amarum*	SU
elephant's foot	*Elephantopus tomentosus*	SU
geranium	*Geranium carolinianum*	SU
horse nettle	*Solanum carolinense*	SU
tropic croton	*Croton glandulosos* var. *septentrionalis*	SU
Sub-shrubs		
green wild indigo	*Baptisia sphaerocarpa*	CR,SU
St.Andrew's cross	*Hypericum hypericoides*	SU
Common Shrubs		
American beauty berry	*Callicarpa Americana*	CR, SU
southern wax myrtle	*Myrica cerifera*	CR
plainleaf sumac	*Rhus copallinum*	CR,SU
eastern bacchcaris	*Baccharis halimifolia*	CR
devil's-walkingstick	*Aralia spinosa*	CR
Small Trees		
yaupon	*Ilex vomitoria*	CR,SU
winged elm	*Ulmus alata*	CR,SU
American holly	*Ilex opaca*	CR,SU
tree sparkleberry	*Vaccinium arboreum*	CR,SU
rusty blackhaw	*Viburnum rufidulum*	CR,SU
eastern redcedar	*Juniperus virginiana*	CR,SU
sweet bay magnolia	*Magnolia virginiana*	CR,SU
sassafras	*Sassafras albidum*	CR
persimmon	*Diospyros virginiana*	CR
parsley hawthorn	*Crataegus marshallii*	SU
flowering dogwood	*Cornus florida*	SU
Canopy Trees		
sweet gum	*Liquidambar styraciflua*	CR, SU
water oak	*Quercus nigra*	CR, SU
post oak	*Quercus stellata*	CR
blackjack oak	*Quercus marilandica*	CR
black gum	*Nyssa aquatica*	CR
willow oak	*Quercus phellos*	CR
mockernut hickory	*Carya tomentosa*	CR
southern red oak	*Quercus falcate*	SU
white oak	*Quercus alba*	SU
willow oak	*Quercus phellos*	SU
Vines		
poison ivy	*Toxicodendron radicans*	CR,SU
greenbriar	*Smilax* spp	CR,SU
Virginia creeper	*Parthenocissus quinquefolia*	CR,SU
mustang grape	*Vitis rotundifolia*	CR,SU
peppervine	*Ampelopsis arborea*	CR,SU
Alabama supplejack	*Berchemia scandens*	CR,SU
trumpetcreeper	*Campsis radicans*	CR
clematis	*Clematis* sp.	CR

At the site referred to as Cherokee Ridge, a total of 78 hectares were planted in 1985 and row-thinned to a BA of 13.1 m2 ha -1 in 1998. At the outset of the study, soils were classified as Darco, Teneha, and Osier. The topography of the research area is relatively flat upland with mild slopes.

At the site referred to as Sweet Union, 45 hectares were planted in 1982 and row-thinned to a BA of ~ 22.3 m^2/ha in 1998. Soils were classified as Attoyac and Ruston. The topography is similar to the Cherokee Ridge site.

Vegetation Surveys

Four random quadrats within each treatment block were inventoried in April or May, 1999 and again in June or July, 1999. Ground coverage was recorded by class (trace; 1 – 5 percent; 6 – 10 percent;11- 20 percent; 21 – 50 percent; 51 – 75 percent; 76 – 95 percent; 96 – 100 percent) for each vegetation class (species or genus for herbaceous and woody dicots; collectively for graminoids), and number of individuals was recorded for each species of forb, sub-shrub, shrub, vines, small tree, and canopy tree. An individual could be a single stem, a bunch, or a cluster, depending on growth form. Flowering specimens were collected for taxonomic identification. Additional data recorded but not analyzed for this paper includes litter and coarse woody debris (percent coverage using the same classification as ground cover) and percent canopy cover directly over each sampling quadrat. A species list was compiled for each site.

Identical surveys on random quadrats were conducted in late May – early June, 2000. Severe drought precluded sampling in July; most plots showed little growth and most forbs were wilting and dying in July.

Treatments

Herbicide was applied in October, 1999. Accord and Chopper tank mix was applied with a backpack sprayer. At Cherokee Ridge, the mix consisted of 4.5 L Chopper and 2.2 L Accord suspended in 11.2 L Sun-it oil with 76.7 L water per Ha. At Sweet Union, the amount of Accord was increased to 2.5 L. Larger trees were treated with 100 ml of Arsenal AC in 300 ml of water using the “hack-n-squirt” method.

The prescribed burn was conducted during March, 2000 after installing firelines the previous winter. Backfires prevented the spread into most buffer zones, or at least into the next treatment plot. Fertilizer was applied in April, 2000. Urea was applied at a rate of 224 kg/ha N and Diammonium Phosphate (DAP)at a rate of 28 kg/ha P.

Statistical Analysis

Statistical comparisons were conducted using The SAS System (version 8 for Windows). Analysis of variance was determined using General Linear Model Analysis (alpha level of 0.1) to evaluate any changes in species richness or homogeneity, or percent ground cover due to treatments as well as species-specific responses to treatments. Comparisons were based on measures of species richness (number of species per treatment plot, combined for all four sample quadrats per plot), species diversity (using the Shannon index), and percent ground cover classification recorded for each taxon in each quadrat.

Pre-treatment Analysis

Comparisons between sites and between treatment plots were made to determine between-site and within-site homogeneity.

Post-treatment Analysis

Post-treatment analysis consisted of comparing fertilized to unfertilized plots, and burned to unburned plots, as well as looking for interaction between these two treatments. Additionally, comparison between 1999 data and 2000 data were made on each plot. Effects of herbicide were not analyzed after the first year, as most plots with herbicide applied showed little understory growth in the summer after treatment.

Response to treatment of specific species was also analyzed. Frequent species were selected for analysis, including American beauty berry(*Callicarpa americana*), late boneset(*Eupatorium serotina*), poison ivy (*Toxicodendron radicans*), and yellow wood sorrel(*Oxalis stricta*). These species were selected due to their ubiquity at both sites, in many of the plots analyzed, compared to the other species on the list (nearly 100 in all).

RESULTS

Pre-Treatment Site Comparisons

No significant differences were found in either pre-treatment species richness ($P = 0.1026$) or species diversity ($P = 0.1142$) between the two sites.

Species lists for both sites are shown in table 1. While species-specific variability between and within sites clearly exists, no analytic examination of these differences was carried out at this point.

Pre-Treatment Plot Comparisons

No significant differences were found in pre-treatment species richness or species diversity for eight of the ten plots. Plots designated 1 and 3 at Cherokee Ridge had significantly lower species richness ($P < 0.0001$) and species diversity ($P = 0.0003$) than all other plots. These two plots bordered the stream bed; the lowest subplots were significantly wetter in the spring than all the other subplots and had a greater percent of coverage by grass, with fewer trees. The subplots above the bottom had greater slope than all other plots. Significant drought over the last three years could have had a greater impact on these two plots than all the others. Specific values for species diversity and species richness are shown in table 2.

Post-treatment Analysis

No significant difference was found ($P = 0.53$) in total number of individuals per species per plot, species richness, or species diversity, between treatments. A significant reduction in percent ground cover class was identified in plots treated with prescribed burning but not fertilized ($P < 0.0001$). No significant difference was found

Table 2—Species Richness and Shannon Diversity Indices of Pretreatment Plots

Plot	Species Richness	Shannon Index
CR-5	15.375	0.99652
SU-5	15.250	0.89729
SU-2	12.500	0.89382
CR-2	12.625	0.88817
CR-4	13.375	0.86574
SU-1	11.000	0.86515
SU-4	10.250	0.85264
SU-3	9.875	0.80688
CR-3	6.000*	0.68288**
CR-1	6.000*	0.63308**

*indicates significantly different values ($P < 0.0001$).
**indicates significantly different values ($P = 0.0003$).

in the number of individuals, between treatments, for the five selected species.

CONCLUSIONS

Change in Measures of Biodiversity

Species richness and species diversity in understory vegetation appear, on the basis of these preliminary results, to be unaffected by the treatments applied to increase growth in the planted pine overstory.

Response of Ground Cover

There is a significantly lower percent ground cover on plots that were not fertilized after burning, compared to plots that were fertilized after burning and compared to unburned plots, with or without fertilizer. Fertilizer alone did not significantly increase percent ground cover, nor did the prescribed burn significantly alter percent ground cover on fertilized plots. Only on unfertilized plots did the prescribed burn reduce percent ground cover in the same year as the burn.

Based on these first-year results, foresters could predict that treating plots with prescribed burning alone can reduce understory ground cover in the following growing season, while treating plots with fertilizer alone will not affect ground cover, and applying fertilizer to burned plots can offset the effect of burning on ground cover.

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