WILDLIFE DAMAGE TO SEEDLINGS IN REFORESTED HARDWOOD SITES IN MISSISSIPPI

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Abstract: Herbivory assessments were conducted on seven reforested sites that were less than one year old in the following Mississippi counties: Bolivar, Leflore, and Attala. At each site, 100ft. x 100 ft. plots were established and randomly selected seedlings were marked and measured to determine seedling species, height, condition, survival, and type and extent of animal feeding sign. Surveys were conducted in March/April, May, and August 2004. Herbivory rates were highest during May with approximately 47% of seedlings showing signs of herbivory. In March/April and August, the percentage of seedlings exhibiting signs of herbivory was 37% and 30%, respectively. Foraging by white-tailed deer (*Odocoileus virginianus*) was recorded on > 90% of the damaged seedlings during each survey. Tree mortality for all study sites and tree species was negligible, with the highest amount (7%) recorded during August, despite the recorded rates of herbivory by white-tailed deer. Herbivory by rabbits (*Sylvilagus* spp.) and rodents occurred on approximately 6% of the seedlings throughout the 2004 growing season.

Key words: bottomland hardwood restoration, herbivory, Mississippi, Lower Mississippi Alluvial Valley, *Odocoileus virginianus*, reforestation, seedling mortality, white-tailed deer

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INTRODUCTION

Before European settlement, the Lower Mississippi Alluvial Valley was a vast expanse of forested wetlands and alluvial floodplain forests. It is estimated that the floodplain of the lower Mississippi River contained 8.5 to 9.5 million ha of forested wetlands in the mid 1700's. By the mid 1930's, approximately half of the forests had been cleared for agriculture (Stanturf et al. 1998). Between the mid 1970's and the mid 1980's, almost 1 million acres of bottomland hardwood wetlands in the Lower Mississippi Alluvial Plain were converted to agriculture. During this period, approximately 365,000 acres of forested wetlands in the state of Mississippi alone were lost (Hefner et al. 1994).

Reforestation of land within the Mississippi River Delta has increased due to the acquisition of land by federal and state agencies, and incentives provided to private landowners through federal cost-share programs such as the Conservation Reserve Program (CRP) and the Wetland Reserve Program (WRP). According to the Natural Resources Conservation Service (NRCS) (2003), Mississippi has the second largest enrollment of WRP acres in the United States. Reforestation of bottomland hardwood has been completed on approximately 68,000 acres in Mississippi since the WRP pilot program began in 1992. In addition to federal cost-share programs sponsored by NRCS, professionals of the Department of Energy, U.S. Fish and Wildlife Service, and private industry are currently working cooperatively on reforestation in the Lower Mississippi Alluvial Valley to reduce the rate of global warming through increased carbon sequestration. From 1968-1998, approximately 36,000 ha were planted in bottomland hardwood species by federal and state agencies in Mississippi (Schoenholtz et al. 2001).

Failures or decreased success of reforestation attempts can be attributed to drought, flooding, or predation by mammals and birds (Harmer 1994, Stanturf et al. 1998). In a survey conducted by King and Keeland (1999), 19 of 27 respondents stated that herbivory was a problem in restoration attempts. Some of the mammal species causing losses can include beaver (*Castor canadensis*) (Krinard and Johnson 1981), white-tailed deer (*Odocoileus virginianus*), rabbits (*Sylvilagus* spp.), and cotton rats (*Sigmodon hispidus*) (Schweitzer and Stanturf 1999).

Our objectives were to assess and quantify wildlife damage to reforestation sites and attempt to determine which wildlife species were responsible for the losses.

STUDY AREAS AND METHODS

Research was conducted in the following three counties in Mississippi: Attala, Bolivar, and Leflore. Counties were selected after contacting NRCS offices and identifying available sites less than one year of age. Two fields in Bolivar and Leflore counties and three fields in Attala county were then selected as study sites based on landowner permission. Two to five plots (100 ft x 100 ft), depending on field size, were established in each field. Seedlings were then randomly selected and flagged in each plot.

A combined total of 25 plots and 708 seedlings were for used for sampling. Each site was surveyed three times throughout the growing season. Initial site visits were made to Leflore and Attala counties during the week of March 13-17, 2004. Due to severe weather, the initial site visit to Bolivar county was made on April 4, 2004. The other two sampling visits for all three sites were conducted from May 11-13, 2004 and August 7-9, 2004, respectively.

Site size (acres), site configuration, prescribed species and arrangement, date planted, tree spacing, and pre- and post planting vegetation management were recorded once for each site using site prescriptions provided by the NRCS agent in each county. Prescribed species for each site consisted of a variety of oak species (*Quercus* spp.) along with green ash (*Fraxinus pennsylvanica*) (Table 1). Dominant vegetation on each site was recorded as grasses or broadleaf during each sampling period. Approximate vegetation height and surface water (percent of total area) were visually estimated during each visit. Each change in cover type that bordered the planted sites was recorded once for each site as adjacent habitat. The species of each sample tree was recorded after leaf out to ensure proper identification. All other sample tree measurements were taken individually during each sampling period. The height of sample trees was measured from ground level to the tallest living portion. Distance from the nearest edge was estimated for each tree. These distances were based on the distance from the nearest change in cover type. Bark, twig, and leaf conditions were measured for each sample tree. These conditions were measured as a percent of the corresponding factor (bark, twig, or leaf) damaged regardless of damage source. The presence or absence of mammalian herbivory was determined for each sample tree. The species responsible for damage was identified based on guidelines reported by Dolbeer et al (1994) in the Prevention and Control of Wildlife Damage Manual.

Table 1. Hardwood species prescribed for reforestation in Attala, Bolivar, and Leflore county study sites in 2004.

Study Site	Species[1]
Attala County	
A1-1	white oak, southern red oak, water oak, cherrybark oak
A2-1	water oak, cherrybark oak
A2-2	white oak, southern red oak
Boliver County	
B1-1	nuttall oak, water oak, willow oak, cherrybark oak, sawtooth oak, green ash
B2-1	nuttall oak, water oak, willow oak, cherrybark oak, sawtooth oak, green ash
Leflore County	
L1-1	nuttall oak, water oak, willow oak, green ash
L2-1	nuttall oak, water oak, willow oak, green ash

[1]White oak (*Quercus alba*), Southern red oak (*Q. falcata*), Water oak (*Q. nigra*), Cherrybark oak (*Q. pagoda*), Nuttall oak (*Q. nuttallii*), Willow oak (*Q. phellos*), Green ash (*Fraxinus pennsylvanica*)

Pre-planting treatments were different for each of the study sites. Sites were disked, bush-hogged, or treated with herbicide before planting.

Contingency table analysis (Dowdy and Wearden 1991) was used to determine if herbivory rates were different among sample periods. For all samples, >90% of herbivory was attributed to white-tailed deer, so rabbit and small rodent herbivory was considered negligible and analyses to determine differences in herbivory rates among animal groups were not attempted. Data was grouped by percentage of tree seedlings with and without signs of herbivory.

A Wilcoxon rank sum test (Conover 1980) was used to test for a difference in tree seedling mortality between sample period 2 and 3. Sample data for period one was not used because tree seedlings were selected for monitoring on that occasion, and their status was recorded on subsequent sample periods. Percentage of dead trees was calculated for each study site providing a sample size of 7 for each sample period.

A Kruskal-Wallis test (Conover 1980) was used to determine differences among sites in tree seedling mortality. Percentage of dead trees for sample periods 2 and 3 was used as the response variable providing a sample size of 2 for each study site. All statistical tests were performed using STATISTIX 7.0 software, and significance level for all tests was $\alpha = 0.05$.

Analyses were based on a sample size of 525 seedlings. By survey 3, 183 seedlings of the original 708 could not be located. The loss of these seedlings could not be attributed to any one factor. Possibilities include herbivory, mortality, human interference, loss of markers, and inability to locate markers due to thick vegetation. Vegetation height on the study sites during survey 2 ranged from 10 – 48 inches and by survey 3, from 36 – 78 inches. Because of these factors, the 183 "missing" seedlings were eliminated from the analyses.

RESULTS AND DISCUSSION

A significant difference was found for herbivory rates among sample periods (χ^2 = 6.97, p-value = 0.031, df = 2). Recorded herbivory rates were highest for survey 2 at 47.4% (Table 2). Herbivory rates for surveys 1 and 3 were 37.5% and 29.9%, respectively. Deer were responsible for over 90% of the recorded damage to seedlings during all three surveys (Table 3). Rabbit damage was highest (6.6%) during survey 1 and almost non-existent by survey 3 at < 1%. Small rodent damage was only recorded during survey 3 (7.0%). When combined over all study sites and surveys, herbivory by rabbits and small rodents occurred on approximately 6% of all seedlings.

Table 2. Herbivory rates for seedlings showing signs of damage recorded during each survey in Bolivar, Leflore, and Attala county reforested sites in Mississippi in 2004.

Survey	Number Damaged	Herbivory rate (%)
1	197	37.5
2	249	47.4
3	157	29.9

Table 3. Herbivory rates for white-tailed deer, rabbits, and rodents recorded during each survey on seedlings in Bolivar, Leflore, and Attala county reforested sites in Mississippi.

Survey	White-tailed deer	Rabbits	Rodents
1	93.4%	6.6%	0%
2	97.6%	2.4%	0%
3	92.4%	0.6%	7.0%

Overall, seedling mortality was negligible. There was no significant difference in tree mortality between survey periods 2 and 3 (Mann-Whitney U = 11.5, p-value = 0.0903, N = 7,7) or among study sites (K-W statistic = 5.879, p-value = 0.437). During survey 2, only 1.3% of the seedlings surveyed were recorded as dead and approximately 7.1% were recorded dead during survey 3 (Table 4).

Table 4. Mortality rates for hardwood seedlings recorded during surveys 2 and 3 in Bolivar, Leflore, and Attala county reforested sites in Mississippi.

Survey	Number of dead seedlings	Mortality rate (%)
2	7	1.3
3	37	7.1

Our results showed that mammalian herbivory contributed little to seedling mortality in the first few months after planting. As reported by Stange and Shea (1998), we also found browsing by white-tailed deer was significantly greater than that of smaller mammals such as rabbits, cotton rats, voles, and mice. Our low mortality rates may be due to the fact that seedlings often demonstrate high resiliency to deer browsing (Jacobs 1969, Lasher and Hill 1977, Cadenasso and Pickett 2000, Sweeney et al. 2002). Lasher and Hill (1977) found that deer browsing on Nuttall, cherrybark, and water oak seedlings in Alabama did not increase mortality, even with cumulative browse damage reaching 123.5 percent. Cadenasso and Pickett (2000) noted that seedlings browsed by deer were more likely to resprout than those clipped by voles. However, heavy browsing pressure by deer can result in reduced height growth and a more bushy appearance in seedlings (Crouch and Paulson 1968, Lasher and Hill 1977, Metzger 1977, Canham et al. 1994, Stange and Shea 1998, Sweeney et al. 2002). Canham et al. (1994) also suggested that, compared with winter browsing, browsing during late spring and early summer caused a significant decrease in seedling growth and survival rates.

Our herbivory rates were highest during May, which we attribute to the attraction that deer would have to new growth on the seedlings. The lowest herbivory rates were recorded in August. By this time, there should have been plenty of other browse available to the deer and many of the seedlings were concealed by thick vegetation ranging in height from 36-78 inches.

Small mammal herbivory was minimal throughout the survey period. Rabbit herbivory was highest during the March/April survey period, but was almost non-existent by August. Seedlings on all of our study sites were planted during February or early March when there was little or no green vegetation. Study sites were also either mowed, disked or treated with herbicide before planting. During winter months, rabbits will often damage seedlings when preferred foods are scarce. Throughout the survey period there was no vegetation control on any of the study sites, therefore, rabbits were provided an abundance of preferred foods once spring arrived. No rodent (vole and cottonrat) herbivory was recorded until the August survey period. Rodent populations were likely minimal in the study sites until the vegetation had become established. Ostfeld et al. (1997) found that higher seedling predation by meadow voles (*Microtus pennsylvanicus*) occurred in sites with a high percent cover of herbaceous plants.

In conclusion, herbivory appeared to have only a minimal effect on hardwood seedling survival during the first 6 months after planting. However, continued herbivory in these hardwood restoration sites may alter community structure and composition (Jones et al. 1997).

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