

Financial returns of wildlife habitat improvement programs in mid-rotation CRP loblolly pine plantations

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Abstract

Provisions of the 2002 Farm Bill provide Conservation Reserve Program (CRP) participants greater flexibility to implement mid-contract management activities that encourage wildlife habitat improvement and timber production. Quality Vegetation Management (QVM) is one mid-contract management technique that utilizes the selective herbicide imazapyr and prescribed burning. Financial rates of return and avian community responses (relative abundance, species richness, and total avian conservation value) were evaluated in mid-rotation CRP loblolly pine plantations in two physiographic regions of Mississippi following QVM application. At two years post-treatment, increases in the relative abundance of 6 early successional bird species were detected on treated sites. Although not significant, mean pine growth increment increases were slightly greater on treated plots than on control plots. Previous studies indicated that the value response increases over time, and positive rates of return become statistically significant sometime after year five. The value of timber on treated plots has increased by \$22.23 more per acre by year two than on control plots, and if ultimately attributable to the QVM treatment, would partially offset the cost of habitat improvement.

Keywords: imazapyr, prescribed fire, birds

Introduction

Since the late 1950's, several federal programs (e.g., Conservation Reserve phase of the Soil Bank, Forestry Incentives Program) have promoted forest management on private lands (Allen et al. 1996). Although the majority (34 million acres) of land enrolled in the Conservation Reserve Program (CRP) is distributed throughout the Midwestern and Great Plains states, the program has had a tremendous impact on land-use changes in the Southeast as well (Burger 2000). Through February 2005, 3,271,838 acres were enrolled in the CRP across 12 southeastern states (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia) (USDA 2005). In the Midwest, the predominant conservation practice is grass establishment, whereas tree planting has been the most commonly enrolled practice in the Southeast, representing 1,868,893 acres, or 57 percent of the total enrolled acres as of February 2005 (USDA 2005). Pine plantings, either newly established plantations or previously enrolled plantations represent 48 percent of these acres (USDA 2005).

Disturbance-dependent habitats are in decline in the Southeast as many of the land-use changes (urbanization, modernized farming, introduction of exotic and monoculture communities) within these forested systems have resulted in the loss of many early successional habitats (Hunter et al. 2001, Burger 2000). As a result, many bird species dependent on these communities are declining in the Southeast. However, the enrollment of agricultural lands into the CRP has the potential to provide early successional habitat for many regionally declining grassland and shrub-successional bird species. Despite the success of CRP in the Great Plains and Midwest, responses of grassland and disturbance dependent bird species in the Southeast have not been as positive, largely because of the relatively short window of early successional habitat in planted pines and lack of mid-rotation management.

Under the 2002 Farm Bill, mid-contract management practices permitted on CRP lands, include thinning, prescribed burning, disking, herbicide, and interseeding of legumes, and effective February 2004, are now encouraged through cost-share payments (USDA 2003a, USDA 2003b). Quality Vegetation Management (QVM) is a habitat improvement technique that utilizes a combination of the selective herbicide Arsenal® Applicators Concentrate (ArsenalAC) and prescribed burning to improve wildlife habitat and timber production. The application of ArsenalAC during the late growing season controls most lower to midstory hardwood encroachment with minimal long-term effects on forbs and grasses (Hurst 1989). In a study on the effects of using ArsenalAC for pine release, Hurst (1989) found that it was effective for controlling midstory hardwoods, but important wildlife plants such as blackberry, dewberry, greenbrier, and other various legumes recovered quickly following initial setback. Prescribed burns conducted during winter are beneficial for wildlife foods by stimulating prolific sprouting from understory plants and permitting more light to aid herbaceous growth (Chen et al. 1975, Dills 1970).

From plantation establishment until stand maturity, competing vegetation will affect the growth of desired crop trees. Some competition may be beneficial as it helps maintain good tree form and natural pruning; however, substantial competition, usually from other plant species, will

negatively affect pine growth through competition for important resources (Schultz 1997). Numerous studies reported significant growth responses to competition control in young pine plantations (Bacon and Zedaker 1987, Creighton et al. 1987, Knowe et al. 1985), and others have demonstrated significant increases in growth with mid-rotation control of competing hardwoods (Fortson et al. 1996, Oppenheimer et al. 1989).

Quality Vegetation Management studies have been conducted in mature (45 - 50 years old) naturally regenerated pine stands (Edwards et al. 2004, Jones et al. 2003) and mid-rotation commercial pine plantations planted on reforested sites (Woodall 2005, Thompson 2002, Hood 2001) in east-central Mississippi, where the hardwood rootstock and seed sources are abundant. In both instances, preliminary results indicate that QVM may improve wildlife habitat quality; however, research is lacking on the effects of QVM on wildlife habitat and timber production in CRP pine plantations, where hardwood competition is largely absent at planting.

Methods

Study Area and Treatments

This study was conducted in the Upper and Lower Coastal Plain physiographic regions of Mississippi. Six study sites (blocks) were located in Kemper (4 sites) and Neshoba (2 sites) counties in East Central Mississippi (UCP) and six study sites were located in Lincoln (3 sites) and Covington (3 sites) counties in southern Mississippi (LCP). Study sites were chosen based on stand age (15-18 years-old), and enrollment in the Conservation Reserve Program. All sites consisted of approximately 45 acres of privately owned, mid-rotation pine plantation which had been thinned prior to the start of the study. There were two treatments at each study site (block), a control, and an ArsenalAC application combined with a winter burn (QVM), which were randomly assigned to 20-acre plots within each study site. On the QVM treated plots, a mixture of 0.5 pounds active ingredient imazapyr, and a surfactant in 20 gallons of total spray solution per acre was broadcast by skidder during October–December 2002, followed by a prescribed burn during January–March 2003. Pre-treatment stand conditions (number of sites (n); quadratic mean diameter, minimum, maximum diameter at breast height; total height; and volume per acre of pine) were similar between QVM and control plots (Table 1).

Table 1--Pretreatment stand conditions (number of sites (n); quadratic mean diameter, minimum, maximum dbh (inches); total height (feet); volume per acre (cubic feet) by treatment in mid-rotation CRP loblolly pine stands in Mississippi, 2003.

Treatment	n	DBHq	(Min-Max dbh)	Total ht	Volume/acre
Control	12	9.3	(2.0-16.6)	56	1889
QVM	12	9.5	(1.7-22.9)	56	1818

No significant differences were found within any of the three variables of interest (DBHq, $P=0.80$; total height, $P=0.93$; cubic foot volume per acre, $P=0.76$) based on measurements recorded prior to the first growing season post-treatment. The dominant understory species

across study sites in both the UCP and LCP was Chinese privet (*Ligustrum sinense*), an invasive exotic.

Avian Community Sampling

Avian communities were sampled once in June, twice in July and once in August 2003, and once in May, and twice in both June and July 2004. Ten-minute point counts were conducted from three permanently marked sampling stations within each treatment plot. All surveys were conducted between 5:30-10:30 (CST), and only when Breeding Bird Survey weather conditions were satisfied (Robbins et al. 1986). All birds seen or heard were recorded by appropriate time (0-3 min., 4-5 min., 6-10 min.) and distance (<82 feet, 82-164 feet, >164 feet, flyover) combination. Only individuals within 164 feet were included in the analysis. Point count data were used to estimate relative abundance, species richness, and total avian conservation value (TACV). TACV is an index to the habitat-specific relative conservation value of the avian community. It is estimated by weighting relative abundance measures by Partners in Flight species conservation priority scores and summing across all species that occurred in a stand, forest, or habitat type of interest (Nuttall et al. 2003).

Timber Growth and Volume

At 10 of the 12 study sites, nine permanent 0.05 acre sub-plots were established per 20 acre treatment plot with a spacing of 4 x 5 chains. Due to space limitations at one study site, only six 0.05 acre sub-plots were established within each treatment plot, while at another study site acreage limitations again limited the number of 0.05 acre sub-plots in the control treatment plot to six. All trees [pine and merchantable hardwoods (>4.99 inches at diameter at breast height)] in each sub-plot were marked with an aluminum tag at breast height (4.5 feet). Diameter at breast height (dbh), total height (H), and total merchantable height (MH=height to a 3-inch top, quality permitting) were recorded pre-treatment (February–March 2003), and twice following application of the QVM treatment (post-treatment) during the 2003-2004 and 2004-2005 dormant seasons. Diameter at breast height, total height, and total merchantable height measurements were used to calculate total and merchantable cubic foot stem volume for each stem using the equations from Merrifield and Foil (1967). Annual growth was calculated as the difference in individual stem growth increments between years.

Financial Return Calculations

To evaluate financial returns as a result of application of the QVM treatment, internal rates of return were computed. Treatment costs used were current operational per acre treatment costs at the time of application, and revenues were per acre treatment volume totals multiplied by current chip-n-saw prices. Timber prices used in rate of return calculations were 2004 fourth quarter prices obtained from Timber Mart-South (2004).

Results and Discussion

Avian Community Metrics

Species richness (sprich), total abundance (abundance), and TACV did not differ during either 2003 [sprich ($F_{1,11}=0.41$, $P=0.53$); abundance ($F_{1,11}=0.00$, $P=0.97$); TACV ($F_{1,11}=0.07$, $P=0.80$)] or 2004 [sprich ($F_{1,9}=1.40$, $P=0.27$); abundance ($F_{1,9}=1.17$, $P=0.31$); TACV ($F_{1,9}=2.17$, $P=0.17$)] (Table 2).

Table 2--Mean total abundance, mean species richness, mean total avian conservation value, and standard error by year and by treatment in mid-rotation CRP loblolly pine plantations in Mississippi, 2003-2004.

Community indices	2003		2004	
	Control(SE)	QVM(SE)	Control(SE)	QVM(SE)
Mean total abundance	7.86(0.49)	7.85(0.49)	8.08(0.37)	7.73(0.37)
Mean species richness	4.95(0.25)	4.83(0.25)	5.88(0.23)	5.68(0.23)
Mean total avian conservation value	144.93(9.14)	143.04(9.14)	150.98(8.00)	139.86(8.00)

The observed initial reduction in these community indices was expected as the QVM treatment was anticipated to create a shift in the breeding bird community from one dominated by forest interior and edge species to one dominated by early successional, pine-grassland, and shrub successional species. During this shift in bird communities these parameters will decrease slightly until the desired suite of avian species responds to the vegetative shift back to an early successional vegetative community. By year two no increase or decrease in any of the three avian community indices were observed. However, increases in the relative abundance of several early successional species were observed (Table 3).

Table 3--Significant increases ($\alpha = 0.05$) in the relative abundance of the following target avian species was observed on treated plots, 2003-2004.

Common name	Scientific name
Common Yellowthroat	<i>Geothlypis trichas</i>
Downy Woodpecker	<i>Picoides pubescens</i>
Eastern Wood-pewee	<i>Contopus virens</i>
Indigo Bunting	<i>Passerina cyanea</i>
Pine Warbler	<i>Dendroica pinus</i>
Summer Tanager	<i>Piranga rubra</i>

Timber Growth and Financial Return

Similar studies evaluating growth responses from mid-rotation competition control (Quicke 2002, Shiver 1994) reported gains in timber growth, but these gains became evident > 3 years post-treatment. At two years post-treatment all measured variables were greater in QVM plots, but we found no significant differences in these mean growth increments (dbh, $P=0.15$; total

height, $P=0.25$; cubic foot volume per stem, $P=0.06$), between treated and control plots (Table 4).

Table 4--Mean diameter (in.), total height (ft.), and volume per stem (cu. ft.) growth increment on control and QVM plots two years post treatment (9 sites).

Treatment	Diameter	Height	Volume
Control	0.79	5.68	3.2
QVM	0.85	6.04	3.4

Due to a variety of circumstances over the past three years which has resulted in the loss of three stands from the study, two year results are from the nine remaining stands. Although not significant, mean growth increment increases on treated plots tended to be greater than those on control plots. Assuming this increment represents a true treatment effect, application of the QVM treatment resulted in a volume increase of 37.68 cubic feet per acre, or \$22.23 of additional revenue per acre. With the two year increase in value, application of the QVM treatment offset between 20 (without cost share) and 40 (with cost share) percent of wildlife habitat improvement costs (herbicide, herbicide application, and prescribed fire). There are currently two programs included in the 2002 Farm Bill that offer cost sharing for QVM; the Conservation Reserve Program (CRP) and the Wildlife Habitat Incentive Program (WHIP). These programs provide up to \$50 per acre in cost share for QVM, but pine stands must meet specific eligibility criteria (Burger et al. 2004). To earn a 6 percent rate of return by year four without cost share assistance, an increase in volume of 219 cubic feet would need to be produced in treated stands over the next two years. Whereas with cost share assistance a 6 percent rate of return could be achieved with an increase in 69 cubic feet of volume over the next two years. As seen in similar studies (Shiver 1994, Oppenheimer et al. 1989, Pienaar et al. 1983) growth response continues to increase with time since treatment. We expect that the increases in growth observed to this point will become more evident by year four post-treatment or later.

Conclusions

The results presented here give two year post-treatment responses of timber growth and avian communities to the QVM treatment, and, although still early for this type of study, are promising. Increases in the relative abundance of several target avian species was encouraging. Woodall (2005) reported that by year four the total abundance, species richness, and total avian conservation value were greater in QVM treated plots than untreated (control) plots. Ongoing monitoring of bird communities on these sites will determine whether patterns of avian abundance observed in commercial pine plantations occur similarly on CRP pine plantations. Pienaar et al. (1983) demonstrated mid-rotation competition control can be successful in producing gains in timber growth, but usually these gains begin appearing $\geq 3 - 4$ years post-treatment and increase as time since treatment increases. Given more time to monitor timber growth responses to the QVM treatment, we expect to see similar results.

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