CARBON SEQUESTRATION AND NATURAL LONGLEAF PINE ECOSYSTEMS

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Abstract—A fire-maintained longleaf pine (*Pinus palustris* Mill.) ecosystem may offer the best option for carbon (C) sequestration among the southern pines. Longleaf is the longest living of the southern pines, and products from longleaf pine will sequester C longer than most since they are likely to be solid wood products such as structural lumber and poles. In addition, a fire-maintained longleaf pine ecosystem supports a productive understory of grasses and herbaceous plants. A study initiated in 1973 to determine the effects of using prescribed fire for hardwood control is being used to assess the amount of C in the overstory, understory vegetation, litter layer, and soils.

INTRODUCTION

Forested ecosystems have a significant potential for sequestering large amounts of carbon (C) through land management. To fully realize the potential C sequestration capabilities of these ecosystems, there is a need to develop strategies and methods for increasing C sequestration. A fire-maintained longleaf pine-dominated (*Pinus palustris* Mill.) ecosystem may offer one of the best options for C sequestration among the forested ecosystems of the Southeastern United States. Longleaf pine is the longest living of the southern pines, capable of reaching 500 years of age (Platt and others 1988). It will continue to put on growth, even at older ages (West and others 1993). Products from longleaf pine will sequester C longer than most since they are likely to be solid wood products such as structural lumber and poles. In addition to the tree itself, a fire-maintained longleaf pine ecosystem supports a productive understory of grasses and herbaceous plants, which themselves may offer more C storage than the trees. This ecosystem provides habitat for a number of threatened and endangered plant and wildlife species, including red-cockaded woodpeckers, gopher tortoises, and indigo snakes (Hardin and White 1989, Landers and others 1995).

Native Species/Ecosystem Benefits

In addition to wood production, another reason for growing longleaf pine would be the potential ecological benefits derived from the important plant and animal communities associated with longleaf pine ecosystems. A fire-maintained longleaf pine ecosystem is among the most species-rich outside of the tropics. A mesic longleaf woodland may contain 140 vascular species per 1,000 m^2, the largest values reported for the temperate Western Hemisphere (Peet and Allard 1993).

As part of the U.S. Forest Service Northern Global Change Program, a project was conducted to estimate current C storage on selected Department of Defense installations and to evaluate the future C sequestration potential of these lands under different forest management scenarios (Hoover 2000). Multiple stand growth simulations were run on a 40-ha stand with a rotation age of 40 years. The parameters tested were site index, initial stocking level, and survivorship at 10 years. In nearly all cases, the simulations indicated that longleaf pine would store more C than the other three major southern pine species, given the same starting conditions. Results from the old-field longleaf pine plantation simulator indicated there would be C gains due to increased stocking toward the end of the simulation period, when the trees were putting on volume rapidly and continued to do so beyond the 40-year rotation. Holding stocking levels constant and varying site index, a rotation of longleaf pine on a high-quality site stored more C than any other species investigated.

OBJECTIVE

A study was initiated in 1973 to determine the effects of hardwood control treatments on understory plant succession and overstory growth in naturally regenerated stands of longleaf pine (Boyer 1983, 1987, 1991, 1993, 1994). These treatments were combinations of mechanical, chemical, and fire (seasonal and no-burn). Boyer (1995) reported on responses of understory vegetation before, and 7 and 9 years after, treatments. Kush and others (1999, 2000) examined effects of 23 years of different seasonal biennial burns (or no burn) plus supplemental hardwood control treatments on the long-term response of understory vegetation in naturally regenerated longleaf pine forests. Using the study initiated by Boyer, the relationships between prescribed burn treatment and above/below ground biomass and C sequestration are being examined.

METHODS

Study Area

The study was conducted at the Escambia Experimental Forest in south central Escambia County, AL. The forest is maintained by the U.S. Department of Agriculture, Forest Service, Southern Research Station, in cooperation with T.R. Miller Mill Company of Brewton, AL.

Plot Sampling

In early September, 2003, the longleaf pine overstory was remeasured for diameter, and crown and total height. All hardwood trees with a d.b.h. > 0.5 inches were identified, and their d.b.h. and total height were recorded. In late September/early October, 2003, living material with a d.b.h. < 0.5-inches was destructively sampled from nine 9.0-square-foot sample plots per treatment plot. The vegetation was sorted by vegetation classes; i.e., grasses, vines, woody, and herbaceous. The litter layer was sampled from one 1.0-square foot per

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sample plot. The vegetation and litter was oven-dried at 70 °C for 72 hours and weighed. A sub-sample of the dried material was ground with a Wiley Mill and sieved to be used for percent C determination.

Carbon Analyses Protocol

Samples were run on a Thermo Finnigan Flash 1112 N/C (CE Elantech Inc., Italy) according to the machine's standard operating instructions. Twenty percent of all the samples were duplicated to check the instrument's repeatability. One NBS standard and one CE Elantech Inc. certified standard were used in each sample set to check the accuracy of the sample values. A sample set consisted of 31 samples, 2 certified standards, a blank (empty tin capsule), and 6 random duplicate samples. After the samples had been run, SAS (SAS Institute 1999) was used to generate coefficients of variation for each duplicate sample. If the coefficient of variation was higher than 5 percent, the sample was rerun. This continued until the coefficient of variation was lower than 5 percent. Entire sample sets were reweighed and rerun if standards were not within 10 percent of certified standard values.

RESULTS AND DISCUSSION

The no-burn treatment had the highest basal area when compared with the burning treatments. Among the burn treatments, the winter burn plots had a higher basal area with 118.16 square feet acre^{-1}. Among the treatments, the basal area on the winter burn plots was the highest with 116.01 square feet acre^{-1}. The spring burn plots had 114.00 square feet acre^{-1}, and the summer had 112.24 square feet acre^{-1}.

Carbon Sequestration

Table 1 presents the weight of C that was present in the non-longleaf pine vegetation by burning treatment. It must be kept in mind that the last winter season burn before sampling was in February 2003, the spring in May 2002, and the summer in July 2002. There were no statistically significant differences in percent C among the different treatments and vegetation components. Dry weight was multiplied by percent C to get total C for the treatment.

The no-burn treatment had the highest amount of C stored, because there was no fire to reduce the aboveground biomass. Among the burning treatments, the winter had the most C, which is related to the woody vegetation present. Efforts are underway to sample the soils for the amount of C being stored there.

Table 1—The amount of carbon (pounds acre^{-1}) stored in the non-longleaf pine vegetation, by burning treatment, on the Escambia Experimental Forest in Brewton, AL

Season	Layer				
of burn	Woody	Herb	Grass	Vine	Total
Spring	125.89	36.94	32.23	16.07	211.13
Summer	101.38	30.96	25.72	2.77	160.83
Winter	231.91	16.17	48.81	45.43	342.32
No burn	509.13	1.85	0.82	167.06	678.86

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