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Response of carbon accumulation in managed pine stands to different management strategies

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Extending from Virginia to east Texas in the southeastern United States, managed pine plantations are an important component of the region's carbon cycle. An objective of the Pine Integrated Network: Education, Mitigation, and Adaptation project (PINEMAP) is to improve estimates of how ecosystem carbon pools respond to the management strategies used to increase the growth of loblolly pine plantations. Experimental studies (108 total) that have been used to understand plantation productivity and stand dynamics by university-forest industry cooperatives were measured for the carbon stored in the trees, roots, coarse-wood, detritus in soil, forest floor, understory and soils to 1-meter. The age of the studied plantations ranged from 4-26 years at the time of sampling, with 26 years very near the period when these plantations are commonly harvested. Across all study sites, 455 experimental plots were measured.

The average C storage across all pools, sites, and treatments was 192 Mg C ha-1, with the average percentage of the total found in the soil (44%), tree biomass (40%), forest floor (8%), root (5%), soil detritus (2%), understory biomass (1%), and coarse-wood (<1%) pools. Plots had as a treatment either fertilization, competition control, and stand density control (thinning), and every possible combination of treatments including 'no treatment'. A paired plot analysis was used where two plots at a site were examined for relative differences caused by a single treatment and these differences averaged across the region. Thinning as a stand-alone treatment significantly reduced forest floor mass, and the forest floor in the thinned plus either competition control or fertilization was 18.9% and 19.2% less, respectively, than unthinned stands combined with the same treatments. Competition control increased C storage in tree biomass by 12% and thinning decreased tree biomass by 32%. Thinning combined with fertilization or competition control had lower soil carbon (0-1 m) than unthinned-fertilized plots (18% and 22%), with most of the losses observed in deeper soil horizons (0.5-1.0 m). Overall these results suggest that maintaining higher tree densities increases ecosystem carbon storage across multiple pools of C in loblolly pine plantations.