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Defense date: March 30, 2011

Title: "Effects of Wood Harvesting on Forest Biomass and Carbon Sequestration in West Virginia"

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ABSTRACT

EFFECTS OF WOOD HARVESTING ON FOREST BIOMASS AND CARBON SEQUESTRATION IN WEST VIRGINIA

The objective of this research is to evaluate the long-term effects of wood harvesting and sustainable forest timbering practices on forest biomass and carbon sequestration in West Virginia. Although several forest management and carbon models have been coupled for scenario analysis, this integrated modeling approach is novel as it predicts timbering events, disturbance events, and forest stand growth as endogenous processes operating at multiple scales (tree, stand, region, and state). This approach allowed for simulating a number of key micro-scale, cross-scale feedback mechanisms, including the long-term interaction between forest stand volume dynamics, growth, timbering event frequency, and disturbance event frequency at multiple scales. The results of the logistic regression analyses indicated that timber stand value density, tree prices, and plot ownership were key drivers in predicting timber stand and tree selection for commercial timber removal events. Beyond the direct effect of timbering events (i.e., removal of forest biomass), timbering events in West Virginia did not have a statistically significant direct effect on net annual forest stand growth rates, landscape level disturbances, regeneration rates, nor mortality rates. Overall, the integrated model estimated that the average net annual growth rate for West Virginia in 2000 for the validation dataset was 1.35% (1.32% was the 5 year average), which was within 4% of the observed rate of 1.40%. From 2000 to 2050, aboveground biomass and carbon stocks in West Virginia forests are projected to continue to increase, despite increased timbering activity, with nearly half of the state forest acreage being classified in an advanced stage of recovery by 2050 (up from 28% in 2000). However, the rate of annual increase in forest carbon and biomass decelerates over time. This deceleration is due to a projected doubling of the timber removal rates toward mid-century (due to increases in timber prices and stand density), increases in landscape scale disturbances, and declining stand net annual growth, which are all due to increases in stand density. Forest stands with steeper slopes, lower annual average precipitation, and greater stand volume density were more likely to experience a landscape disturbance event, resulting in a net negative growth rate for the stand. Overall, these disturbance events are projected to increase in frequency by approximately 50% from 2000 to 2050, as forest stands increase in stand density. Application of sustainable timbering techniques was found to significantly enhance long-term projections of biomass, carbon, net annual growth (60% higher than status quo), and system carrying capacity.