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Biomass accumulations in mature and old-growth riparian northern hardwood-conifer forests: Implications for forest carbon sequestration

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Managing the contribution of forest ecosystems to global carbon budgets requires accurate predictions of biomass dynamics in relation to stand development. A widely used theoretical model in the northern hardwood region of eastern N. America predicts peaks in biomass after two centuries of stand development followed by declining biomass in stands 200 to 350 years of age and “steady-state” biomass dynamics in stands > 350 years of age. However recent empirical studies have found continued basal area accumulations later into stand development than previously predicted. Our study evaluated these competing views focusing on northern hardwood-conifer forests in the Adirondack Mountains of upstate NY. We sampled 29 sites along 1st and 2nd order stream reaches. Sites were classified as mature forest (9 sites) mature with remnant old-growth trees (5 sites) and old-growth (15 sites). Average age of the largest dominant trees ranged from approx. 81 to 410 years. At each site forest structure was sampled using 6-10 variable radius plots. We used the Northeast Ecosystem Decision Model (NED-2) to calculate tree biomass based on species-specific allometric equations. ANOVA and multiple comparisons were used to analyze categorical data; continuous variables were evaluated using Classification and Regression Trees and linear regression analysis. Aboveground biomass was significantly ($p < 0.001$) different among mature (165 Mg/ha) mature w/remnants (177 Mg/ha) and old-growth (254 Mg/ha) sites. In CART models basal area was the strongest predictor of dom. tree age but aboveground biomass was an important secondary variable. Both basal area ($r^2 = 0.60$) and aboveground biomass ($r^2 = 0.65$) were strongly ($p < 0.001$) and positively correlated with dominant tree age. There was little or no evidence of asymptotic relationships over the range of values examined. Our results support the hypothesis that basal area (live and dead) and aboveground biomass can continue to accumulate very late into succession in northern hardwood-conifer forests. Concurrence among empirical studies suggests a need to reexamine theoretical biomass models for these systems. If the data represent a trend of biomass additions in stands well over 300 years of age a leveling off would have to occur later in stand development than previously predicted. This would have important implications for our understanding of both the quantity and temporal dynamics of carbon storage in old-growth forests.