Simulating the Effects of Disturbances and on Fuel Loading in Forest Ecosystems of Northern Wisconsin, USA

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Summary

Modeling is an important tool to overcome both temporal and spatial limitations in landscape studies. We developed a phenomenological fuel-loading model (Figure 1) to evaluate the effects of ecosystem type and disturbances on fine fuel loading ($Mg.ha^{-1}$). The model effectively predicted live biomass ($r^2 > 0.93$) and fine fuel ($r^2 > 0.93$) (Figure 2&3). To achieve study objectives, four disturbances (defoliation, mortality, fire frequency, and thinning) were applied to three managed forest types (i.e., hardwood, red pine, and jack pine). All four disturbances showed significant ($p=0.001$) effects on fine fuel loading in all ecosystem types except for thinning in jack pine ($p=0.56$). Prescribed burning and thinning were preferred techniques to reduce fuel loading, but were not always effective in all ecosystems. Prescribed burning significantly ($p=0.05$) reduced fine fuel loading only in red pine ecosystem. Significant ($p=0.05$) interactions between fire frequency and other factors (i.e. thinning, defoliation rate, and mortality rate) suggested that prescribed fire should be applied to an ecosystem with considering disturbance history. We did not find evidence showing fine fuel loading reduction by thinning in any of the ecosystems. Fine fuel loading consistently increased by thinning in hardwood ecosystem, while it sometimes decreased by thinning in pine ecosystems. For red pine ecosystem, thinning reduced the variation in the effect of defoliation, fire frequency, and mortality on fine fuel loading. The method of post-thin treatment could be more important than thinning itself in long-term management (>100 years).

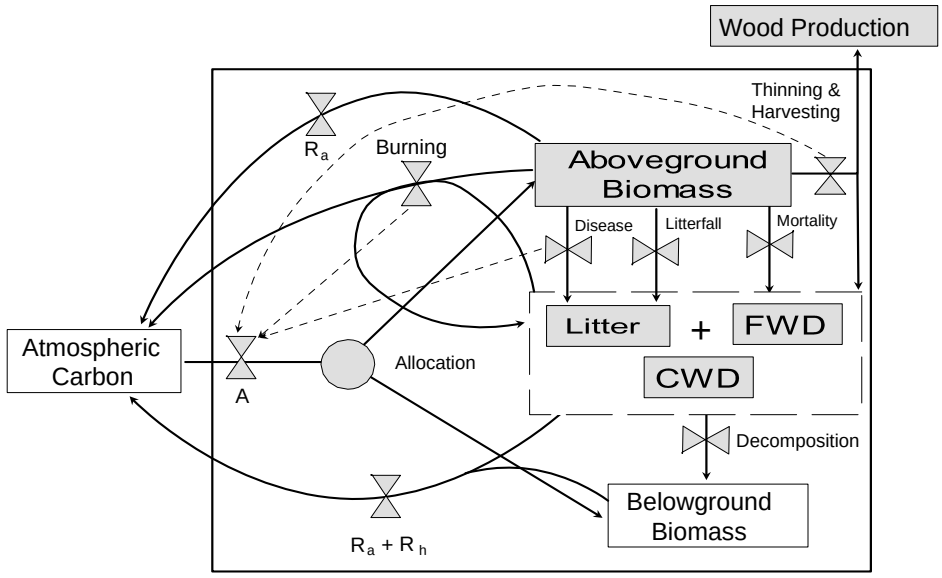

Figure 1. The conceptual diagram of carbon flow in the forest ecosystem. Solid line represents carbon flow and dashed line indicates information flow. A, R_a, and R_h, are total photosynthesis, autotrophic respiration, and heterotrophic respiration, respectively.

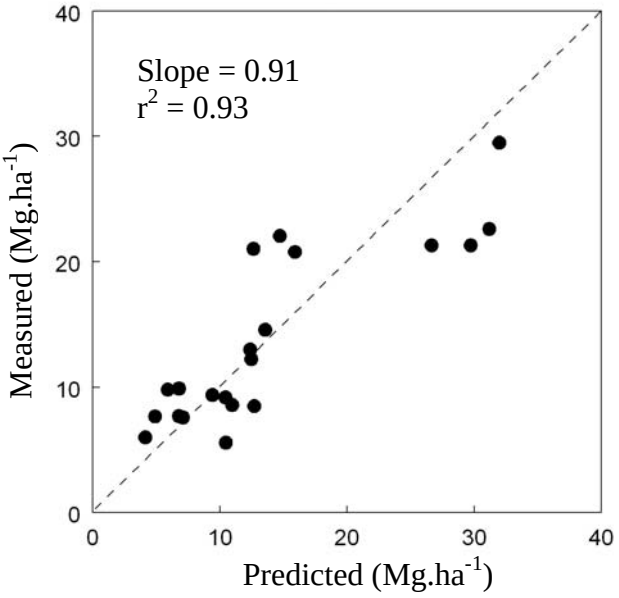

Figure 2. The relationship between measured and predicted fine fuel (<2.5 cm in diameter) on forest floor for three dominant ecosystem types in Northern Wisconsin.

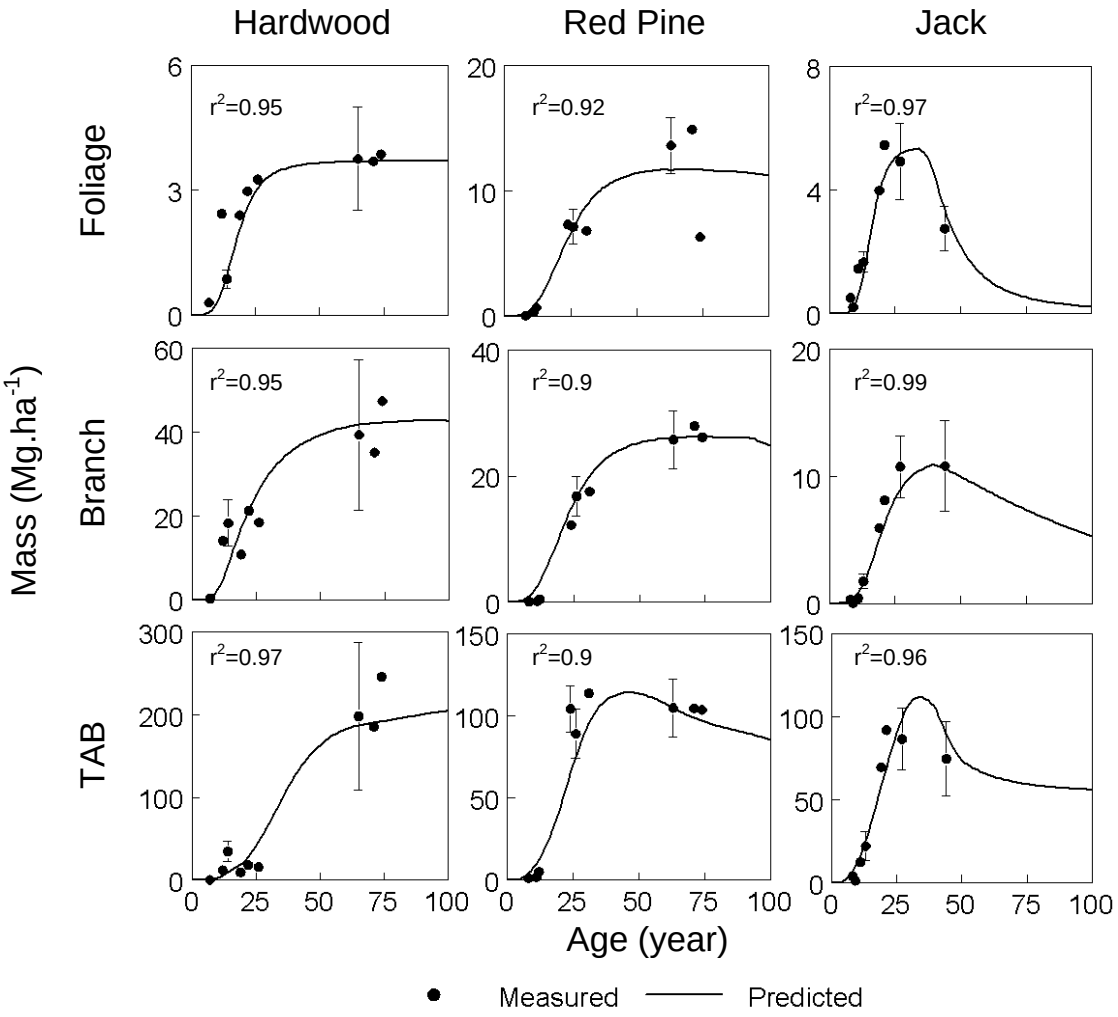

Figure 3. Measured and predicted foliage, branch, and total aboveground biomass (TAB) by age in three studied ecosystems. Biomass of jack pine ecosystem decreased after age 40 due to high natural mortality.

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M.S. Forest Genetics and Forest Ecology, Mar. 1997 – Feb. 1999, Korea University, Seoul, Republic of Korea
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