Doctoral Dissertation Defense

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Long-term temporal dynamics of Duke Forest

Doctoral committee: Robert Peet, Peter White, Dean Urban, Conghe Song, David Peart

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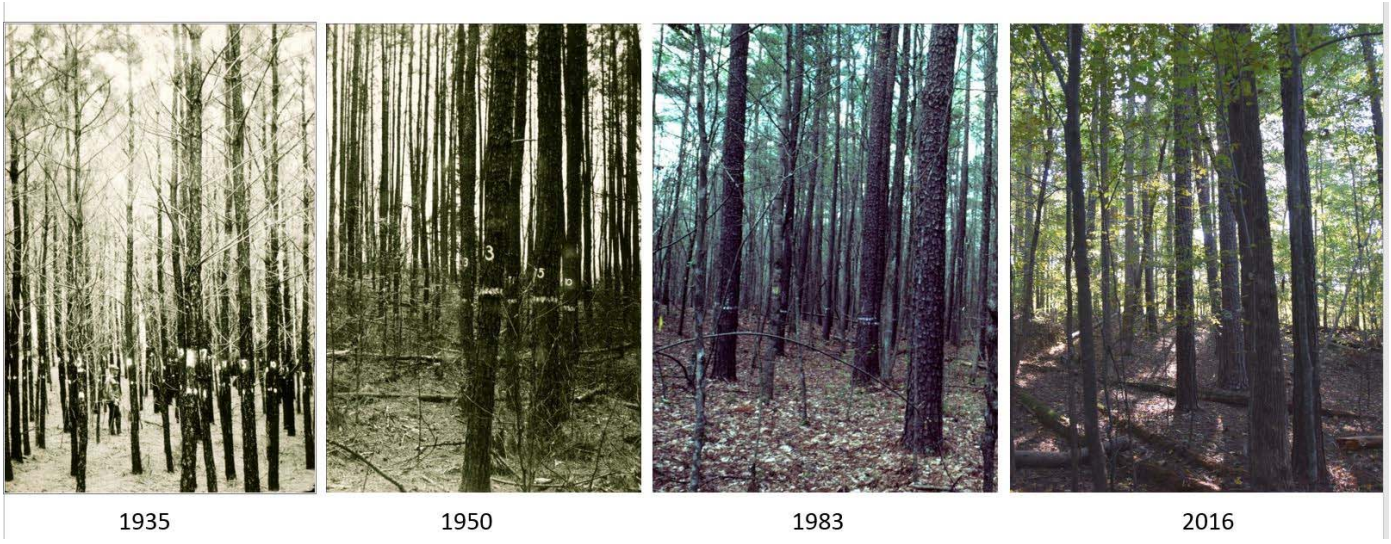
Abstract. In this dissertation, I describe a series of permanent sample plots in the North Carolina Piedmont used to examine near-century forest processes and to evaluate how observed trends can inform existing conceptual theories. Specifically, 80 years of tree growth and forest composition were recorded across all succession phases in a series of successional *Pinus taeda* stands and second-growth *Quercus-Carya* and *Liriodendron-Liquidambar* hardwood stands in the Duke Forest. I used these long-term data to scrutinize classical theories of community dynamics and growth trends in Piedmont forests that have served as a model system for successional research for 100 years. Specifically, using a suite of multivariate statistics I examined whether old-field pine forests have succeeded toward putative climax compositions or whether deviations in successional trajectories have occurred owing to shifts in species compositions and hurricane-mediated disturbance. I additionally examined whether biomass of successional stands could be predicted based on canopy mortality and lags in regeneration and whether growth rates of mature forests have increased more than expected in the last century. 80-year biomass and growth trends in successional plots confirmed the importance of canopy density and mortality in driving these patterns, but lag patterns in post-hurricane regeneration were not yet formally discernible. In contrast, second-growth hardwood plots demonstrated consistent biomass accumulation and continued increases in growth rate, despite achieving biomass levels found in more static old-growth forests. Community analyses indicated that successional stands experienced shifting compositional trajectories that were accelerated by Hurricane Fran and resulted in replacement of upland-associated hardwood species (e.g., *Cornus florida*) with species associated with more mesic stands (e.g., *Acer rubrum*, *Liquidambar styraciflua*, and *Fagus grandifolia*). A similar replacement of putative climax species (e.g., *Quercus alba*) with *A. rubrum* occurred in understories of late-successional hardwood stands. In contrast with accepted successional models, these results are in line with mounting evidence of unanticipated and less predictable forest dynamics in the last century. Such changes could be the result of changing climate patterns or anthropogenic impacts, but regardless, more mechanistic experiments must be developed to determine the cause of these seemingly-widespread patterns to better inform global change and forestry models.



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