Influence of density reduction on growth response, stem quality, and understory dynamics in pole-size hardwood stands

Ryan L. Woods and Douglass F. Jacobs

Purdue University Department of Forestry and Natural Resources and the Hardwood Tree Improvement and Regeneration Center (HTIRC)

Abstract

This study will help ascertain the optimal stand density for ecologic and economic value by quantifying changes in environmental conditions resulting from different density reductions and assessing the influence on the residual stand. This study will examine the effects of two levels of density reduction in relation to growth response, crop tree stem quality, and understory vegetation dynamics in comparison to a control treatment with no thinning.

Introduction

Oaks (*Quercus* spp.) and hickories (*Carya* spp.) are integral components of the ecological and economic systems in many areas of the Central Hardwood Forest Region (CHFR). It has been well documented that even-aged management is the most successful method of regenerating these shade intolerant species. Even-aged regeneration methods produce a high number of stems per unit area where competition for resources is intense; thus, resulting in slower growth rates of crop trees, suppressed stems, and high mortality rates (Schuler 2006). Implementing a thinning regime may help to increase stand productivity and value, attain desirable species composition, and select crop trees. Deciding upon the appropriate level of thinning is vital to achieving the desired gains.

Materials and Methods

Three thinning treatments (100%, 75%, and 60% stocking) were implemented during early spring of 2007 in five pole-size hardwood stands within the Hoosier National Forest (Figure 1). These stands were clearcut harvested between the period of 1975 and 1979. Each stand was inventoried prior to thinning. Development of residual overstory trees and understory vegetation will be monitored over time.

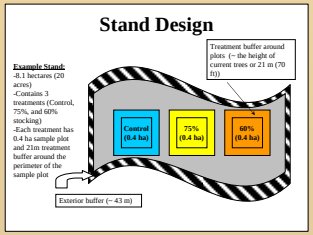

Figure 1. Treatment plot lay out with associated buffers.

Stocking Guide

Growing space is one of the most important factors that contribute to an individual tree's rate of growth. The amount of available growing space in a stand can be quantitatively shown in terms of stand density (Figure 2). Conversely, stand stocking is a qualitative measure that describes the adequacy of a given stand density in regards to obtaining a given management objective.

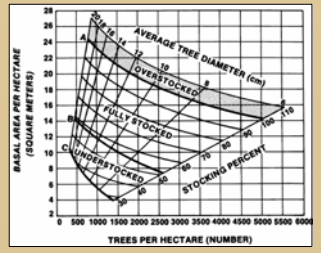

Figure 2. Upland Central Hardwoods stocking guide (Rogers, 1980).

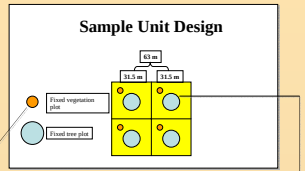

Figure 3. Sampling units of $1m^2$, .04 ha, and .4 ha within each treatment plot. Sampling units are for understory vegetation, overstory trees, and crop trees, respectively.

Understory Vegetation Measurements

- species
- height
- crown class

Overstory Measurements

- species
- diameter at breast height
- crown class

Crop Tree Measurements

- species
- diameter at breast height
- crown class
- height to live crown
- crown area
- free to grow ratings
- epicormic branches

Residual Stand Measurements

- photosynthetically active radiation (PAR)
- canopy closure/leaf area index (LAI) (Figure 9)
- grape vines

Figure 4. Control (100% stocked) plot in 30 year old clear cut hardwood stand.

Figure 5. 75% stocking treatment plot pre-thinning

Figure 7. 60% stocking treatment plot pre-thinning

Figure 6. 75% stocked plot post-thinning

Figure 8. 60% stocked plot post-thinning

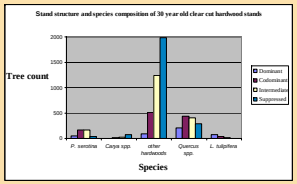

Table 1. Species composition separated by crown class.

Canopy Closure

Hemispherical digital photography is one of the newest technologies being used in silviculture, forest ecology and riparian management. This system provides high resolution 180 degree digital photographs of the forest canopy from the perspective of the forest floor (Figure 9). Photographs of the forest canopy are taken and then downloaded in to a software program that differentiates and counts pixels to compute leaf area index.

This system will be used to measure residual canopy cover as a result of density reductions. Leaf area index, canopy closure and relative amounts of sunlight will be monitored over time.

Figure 9. Hemispherical photograph of a hardwood forest canopy.

Anticipated Results

The ability of understory vegetation to continue to grow and persist will depend on canopy closure time (10-15 years in Yanai et al. (1998)) and an individual stem's ability to reach the canopy or where light is sufficient. Understory PAR levels will be higher in treatments plots with greater density removal, thus, a greater amount of physiological growing space will be available to understory vegetation. Shade tolerant species will be more pronounced and have greater growth in less intensely thinned treatments because of their efficient light usage and intolerant species will be more pronounced in heavily thinned treatments.

Epicormic branching, diameter growth, and crown expansion will be strongly correlated to the amount of overstory density removed. Additional sunlight as a result of fewer overstory stems could trigger epicormic branching. Increases in diameter growth and crown expansion will be more significant in heavily thinned treatment plots as result of a greater available canopy area and less competition of resources.

Acknowledgements:

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