DETECTING RESPONSES OF LOBLOLLY PINE STAND DEVELOPMENT TO SITE-PREPARATION INTENSITY: A MODELING APPROACH

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Abstract-Data from an existing site preparation experiment in the Georgia Piedmont were subjected to a modeling approach to analyze effects of site preparation intensity on stand development of loblolly pine (*Pinus taeda* L.) 5 to 12 years since treatment. An average stand height model that incorporated indicator variables for treatment provided an accurate description of responses to site-preparation intensity, with steepness of the height trajectory increasing with site-preparation intensity. Stand basal area and volume varied similarly among treatments as found for height, with their development increasing with treatment intensity.

INTRODUCTION

It has been widely accepted that development of stand height follows a certain pattern that can be described bv the following model (Clutter and others 1983):

$$\ln(H)=a+b/AGE \quad (1)$$

where

H is stand height,

AGE is stand age, and

a and b are estimated parameters.

Similarly, growth of stand basal area (BA) and stand volume (V) follow a similar pattern as:

$$\ln(Y)=a+b/AGE \quad (2)$$

where

Y is stand basal area or stand volume, and

a, b, and AGE are as defined previously.

The growth pattern of stand height, basal area, and volume can vary with site quality, species, and silvicultural treatments, such as site preparation. For a given species and site, effects of treatments can be detected by incorporating their effects into this model:

$$\ln(Y)=a+b/AGE+cTRMT \quad (3)$$

where

TRMT represents treatment effects,

c is an estimated parameter, and

a, b, and AGE are as defined previously.

In this study, an indicator variable was specified for each treatment to detect effects of site preparation intensity on stand development.

DATA

The data were from an existing site preparation study of loblolly pine (*Pinus taeda* L.) initiated in 1980 in the Georgia Piedmont. After clearcutting mature loblolly pine, the six site-preparation intensities were applied, ranging from absence of site preparation to combinations of mechanical, herbicide, and fertilizer treatments. The treatments are listed as follows in order of increasing intensity:

(1) Clearcut only.

(2) Chainsaw. All residual trees greater than 2.5 centimeters diameter at breast height (d.b.h.) were felled with a chainsaw in August 1981.

(3) Shearing of residual trees with a KG blade mounted on a D7 tractor in September 1981 and chopping of woody debris with a single pass of a rotary-drum chopper in November 1981.

(4) Shear, chop, and herbicide. Treatment 3 plus application of 0.5 cubic centimeters Velpar (TM) Gridball pellets (hexazinone at 10 percent active ingredient) in a 0.6-meter x 0.6-meter grid pattern at a rate of 2.8 kilograms per hectare in March 1982.

(5) Shear, rootrake, burn, and disk. Residual trees were sheared and rootraked into windrows in September 1981 and burned in October 1981. The remaining debris and ash were scattered with a dozer blade and the plots were disked with an offset harrow to a depth of 15-20 centimeters in October 1981.

(6) Shear, rootrake, burn, disk, fertilize, and herbicide. Treatment 5 plus a broadcast application of ammonium- nitrate fertilizer at 114 kilograms N per hectare and a 1 .2-meter band application of Oust (TM) (sulfometuron) at 0.42 kilograms active ingredient per hectare in March and April 1983.

Each treatment was replicated five times in a randomized complete-block design. In January and February 1982, seedlings of loblolly pine were hand-planted at a spacing of 1.8 meters x 3 meters. After establishment of the stands, measurements of d.b.h. (centimeters) and height (meters)

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of each Planted pine were taken 5, 8, 10, and 12 growing seasons after treatment, from which stand average height (H), basal area (BA) (square meters per hectare), and volume (V) (cubic meters per hectare) were calculated. All models were fitted with linear regression using a 95 percent significance level.

RESULTS AND DISCUSSION

Stand Average Height

Fitting stand average height to model (3) resulted in the following equation:

$$\ln(HT)=3.26-9.84/AGE-0.415T1-0.256T2-0.126T3-0.316T4-0.0991T5 \quad (4)$$

where

T1, T2, T3, T4, and T5 are indicator variables that represent treatments 1 to 5, respectively.

For example, TI =1 if treatment is 1, otherwise T1=0.

Equation (4) indicates that development of average height differed significantly among treatments, with rate increasing with site-preparation intensity. Average height of untreated stands was significantly less than that of treated stands ($P \leq 0.05$).

Numerous studies have reported increases in stand height in response to site preparation (Glover and Zutter 1993, Harrington and Edwards 1996, Pienaar and Rheney 1995, Thomson and McMinn 1989). Since stand height is relatively similar for a wide range of stand densities, increases in the rate of height development probably are more attributable to improvement in site quality due to site preparation. Measurements of soil properties on this site demonstrated that the treatments improved growing conditions for pine by decreasing bulk density and increasing pore space (Miller and Edwards 1985).

Stand Basal Area

The following equation resulted from fitting stand basal area to model [3]:

$$\ln(BA)=4.75-919/AGE-1.52T1-1.04T2-0.308T3-0.477T4 \quad (5)$$

The fitted equation (5) indicates that development Of stand basal area also increased with treatment intensity, with the clearcut only treatment having the slowest rate of basal area development.

Stand Volume

Model [3] also was used to test responses of stand volume to treatment:

$$\ln(V)=6.28+24.4/AGE-1.68T1-1.09T2-0.326T3-0.617T4 \quad (6)$$

Stand volume differed significantly among site-preparation intensities, with the clearcut-only treatment having the slowest rate of volume development (fig. 1). Development

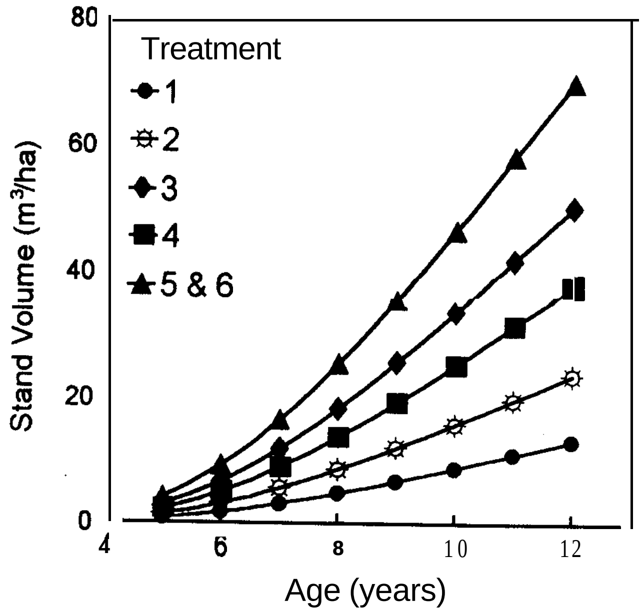

Figure I-Effects of increasing site-preparation intensity on development of stand volume of loblolly pine.

of stand volume did not differ significantly ($P \geq 0.05$) between treatments 5 and 6-the two treatments having the greatest rate of stand development.

CONCLUSIONS

Effects of site preparation on stand development were modeled as adjustments to a growth model for stand average height, basal area, and volume. This approach provided an accurate description of stand responses to site-preparation intensity. Results suggest that the more intensive site preparation treatments lead to greater rates of stand development.

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