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# Shortleaf Pine Growth and Yield

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## Introduction

Growth and yield models are designed to provide a forecast of potential timber yield from managed forests, assisting landowners and land managers in decision-making on management (choice of species, method of regeneration, stand densities, competition control, fertilization, and thinning schedules) and harvesting schedules.[4] Ultimately, these models assist in estimating management costs and income generation.

Growth and yield models are widely used in the timber industry and by timber consultants and nonindustrial private forest landowners (NIPFLs). For NIPFLs, these models can provide guidance on the species and the management regime that meets their economic objectives. Growth and yield models only assist in the economic assessment of timber, and do not include other values (hunting, recreation, aesthetics, biodiversity) that are important to NIPFLs. Additionally, management costs and stumpage prices are difficult to forecast decades in advance.

For southern yellow pine species, there are extensive growth and yield models for loblolly pine, many for slash pine, and some for longleaf pine (D. Dickens, personal communication 2016).[4,12] Information on the growth and yield of shortleaf pine, however, is less comprehensive than the other three southern yellow pines and surprisingly limited for a species that is an important timber resource,[3,4] has the largest range, and is second in volume compared with the other three commercial southern yellow pine species.[12]

The objectives of this fact sheet are to:

- Provide background on the conceptual basis and different types of growth and yield models,
- Provide references that summarize growth and yield models for shortleaf pine, and
- Provide resources for obtaining growth and yield information.

## UNDERSTANDING GROWTH AND YIELD MODELS

The components of a growth and yield model include an estimate of the growth rate of the trees in the stand, the residual basal area and the number (and often the diameter distribution) of stems harvested at a given time. Growth is measured as volume or tonnage per unit area (usually per acre). Both external site characteristics (temperatures, precipitation, light, nutrients, soils, land use history, and other characteristics) and genetic factors influence growth. Yield is measured in board feet or tonnage.

There are several types of growth and yield models that can be developed, based on the stand type and type of study. Additionally, the geographic area where the model was developed in the species' range is an important consideration.

### *Stand Type*

Models for even-aged stands that will be harvested completely at one point in time are the easiest and most accurate models that can be developed. Models are more difficult to develop and the accuracy decreases for products that mature at different times or products that become mature over a span of years (pulpwood during several thinnings, poles and sawtimber during later harvesting).[11] Uneven-aged stands and stands with variable site quality and/or site history are the most difficult stand types to model accurately (J. Guldin, personal communication 2016).

The parameters gathered for a growth and yield model differ by stand type. For plantations with the same species and one age class the stand level parameters of age, density, and site quality are measured to estimate basal area (BA: usually expressed as square feet per acre) and wood volume at a per acre basis. An even-aged stand which has the same species but multiple age classes, the parameters of diameter at breast height (DBH; diameter measured at 4.5 feet above the ground) class, density, and site quality by tree size class are used to estimate BA and volume by tree size class. A mixed forest, with different species, the parameters of DBH, total height, and height to crown base are measured over time at the individual tree level to provide an estimate of growth and total volume at the tree scale.[8] Mixed forest stands are the most common type on private, nonindustrial lands in Arkansas and Oklahoma.[12]

**Table 1. List of Growth and Yield Models for Shortleaf Pine**

| Geography | Stand Type | Study Type | Date | Authors |
|---|---|---|---|---|
| SE US | Natural Even-Aged | Descriptive | 1929 | USDA Forest Service |
| West of Mississippi River | Natural Even-Aged | Predictive | 1986 | Murphy |
| Ozark and Ouachitas NFs | Natural Even-Aged | Predictive | 1999 | Lynch et al. |
| Missouri | Natural Even-Aged | Inferential | 1985 | Rogers and Sander |
| Oklahoma | Natural Even-Aged | Inferential | 1996 | Wittwer et al. |
| Oklahoma | Natural Even-Aged | Inferential | 2009 | Sabatia et al. |
| Arkansas | Natural Uneven-Aged | Inferential | 1985 | Murphy and Farrar |
| Arkansas | Natural Uneven-Aged | Predictive | 2000 | Huebschmann et al. |
| Missouri Ozarks | Natural Uneven-Aged | Predictive | 2011 | Lhotka and Loewenstein |
| Tennessee | Plantations | Predictive | 1974 | Smalley and Bailey |

### *Types of Growth and Yield Studies*

There are three types of growth and yield studies.[4,12] Descriptive studies are observations on growth, usually of some unusual phenomenon such as a rare stocking density or comparisons of different species growing on the same site. They have limited value for understanding growth and yield on other sites and are not based on empirical data. Inferential studies are statistically designed experiments to test the outcomes of a specific management action or natural event. They are usually very intensive studies, focusing on a limited number of parameters to determine a cause and effect relationship between a management action and the growth response of the species.

Predictive studies are designed to develop models of growth and yield that can be used across a range of site conditions.[12] They usually measure a range of variables that allow the prediction of growth and yield in a diversity of situations, including stand density, site index, management history, and stand treatment, including sampling over time to capture responses to different climatic conditions. Age of the forest is also important, as is the use of competition control, fertilization, and tree improvement has increased in recent decades. The most accurate data is obtained through the resampling of permanent plots. To get precise data for the range of variables, a large number of plots, sometimes hundreds of plots, are required. Growth and yield models are not developed quickly.

### *Geographic Range of Study*

Growth and yield models are most accurate for the site or region where they are developed and lose accuracy when extrapolated to other regions. The majority of growth and yield models are from Arkansas, Oklahoma, and Missouri,[12] with few in other portions of shortleaf's range.[8] This results in a lack of accurate growth and yield data for most of the range of the species.

Thus, the most informative growth and yield model for a landowner will be one that is done for the same stand type, developed from a predictive study, and in the same geographic region.

## REVIEW OF GROWTH AND YIELD MODELS

While growth and yield models are not as comprehensive for shortleaf pine as the other major southern yellow pines, there are still several examples for natural stands of even-aged and uneven-aged shortleaf (Table 1).[1,3,8] Will et al. (2013) recently summarized growth and yield models from the literature for shortleaf pine. They noted, however, that no comprehensive models have been developed for shortleaf pine plantations in recent decades. For studies done before 1986, Murphy (1986) provides a comprehensive discussion.

## RESOURCES FOR DEVELOPING GROWTH AND YIELD MODELS

How does a nonindustrial private forest landowner interested in growing shortleaf pine proceed when there is not a specific growth and yield model for their geographic area, stand type, and site condition?

It is recommended that the landowner contact the state forestry agency, the state university Cooperative Extension personnel that provide forestry assistance, and a local forestry consultant. Contact information for these services can be found in the Resources section of this fact sheet.

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# Resources

## For the location and phone numbers of state agencies in the southeastern U.S. providing forestry assistance and information, see the following websites:

**Alabama Forestry Commission:** http://www.forestry.alabama.gov/

**Arkansas Forestry Commission:** https://www.agriculture.arkansas.gov/arkansas-forestry-commission

**Florida Forest Service:** http://www.floridaforestservice.com/

**Georgia Forestry Commission:** http://www.gatrees.org/

**Kentucky Division of Forestry:** https://eec.ky.gov/pages/index.aspx

**Louisiana Department of Agriculture and Forestry:** http://www.ldaf.state.la.us/

**Mississippi Forestry Commission:** http://www.mfc.ms.gov/

**North Carolina Forest Service:** http://www.ncforestservice.gov/

**Oklahoma Forestry Services:** http://www.forestry.ok.gov/

**South Carolina Forestry Commission:** http://www.state.sc.us/forest/

**Tennessee Division of Forestry:** https://www.tn.gov/agriculture/forests.html

**Texas A&M Forest Service:** https://tfsweb.tamu.edu/

**Virginia Department of Forestry:** http://www.dof.virginia.gov/

## For the location and phone numbers of University Extension personnel in the southeastern U.S. providing forestry assistance and information, see the following websites:

**Alabama Cooperative Extension System:** http://www.aces.edu/

**University of Arkansas Cooperative Extension Service:** http://www.uaex.edu/

**University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS):** https://sfyl.ifas.ufl.edu/

**University of Georgia Extension:** http://extension.uga.edu/

**Kentucky Cooperative Extension Service:** https://extension.ca.uky.edu/

**Louisiana Cooperative Extension Service:** http://www.lsuagcenter.com/

**Mississippi State University Extension Service:** http://extension.msstate.edu/

**North Carolina Cooperative Extension:** https://www.ces.ncsu.edu/

**Oklahoma Cooperative Extension Service:** https://go.okstate.edu/about-osu/oces.html

**Clemson Cooperative Extension (South Carolina):** http://www.clemson.edu/extension/

**University of Tennessee Extension:** https://extension.tennessee.edu/

**Texas A&M AgriLife Extension:** http://agrilifeextension.tamu.edu/

**Virginia Cooperative Extension:** http://www.ext.vt.edu/

## Connecting with a Consulting Forester
## Go to the Association of Consulting Foresters website:

http://www.acf-foresters.org/acfweb. Click on "Find a Forester", then select your state in the "People Search – Public" search page.

## For information on how to select a consulting forester, go to:

http://extension.msstate.edu/publications/publications/choosing-consulting-forester

https://texashelp.tamu.edu/wp-content/uploads/2016/02/ER-038-Selecting-a-Consulting-Forester.pdf

http://www.uaex.edu/environment-nature/forestry/FSA-5019.pdf