USER'S GUIDE TO A MULTIPURPOSE FOREST PROJECTION SYSTEM FOR SOUTHERN FORESTS

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Information contained herein is available to all without regard to race, color, sex, or national origin.

USER'S GUIDE to a Multipurpose Forest Projection System for Southern Forests[1]

ROGER K. BOLTON and RALPH S. MELDAHL[2]

INTRODUCTION

APPROXIMATELY 40 percent of the timberland in the United States is located in the South. This publication is a brief introduction and user's guide for a projection system based on data from the State of Georgia[3]. This system allows various management options to be explored on forestland, not only in Georgia but in similar adjoining areas in the South.

Georgia is the largest state east of the Mississippi River, with a total land area of 37.3 million acres. Of this total land area, 64 percent is classified as commercial forestland *(7)*. These forests support a large forest industry and provide wildlife habitat, watershed protection, and a range of outdoor recreational opportunities. Within this resource, a prodigious amount of diversity occurs. For example, Georgia is often divided into five physiographic regions. The five physiographic regions, shown in figure 1, are the Lower Coastal Plain, the Upper Coastal Plain, the Piedmont, the Valley and Ridge, and the Blue Ridge Mountains *(8)*. These regions are occupied by six major forest types (loblolly pine, shortleaf pine, slash pine, oak-pine, oak- hickory, oak-gum-cypress), a copious mixture of species, and a mixture of stand conditions.

Due to the complex structure of natural stands and the myriad conditions found within Georgia, a distance-independent, individual tree model was selected for the modeling methodology *(5)*. In this

[1]Project jointly funded by the Alabama Agricultural Experiment Station, Forest Resources System Institute (FORS), and Georgia Forestry Commission.
[2]Research Associate and Assistant Professor of Forestry.
[3]Details about the projection system are reported in Alabama Agricultural Experiment Station Bulletin 603, "Design and Development of a Multipurpose Forest Projection System for Southern Forests."

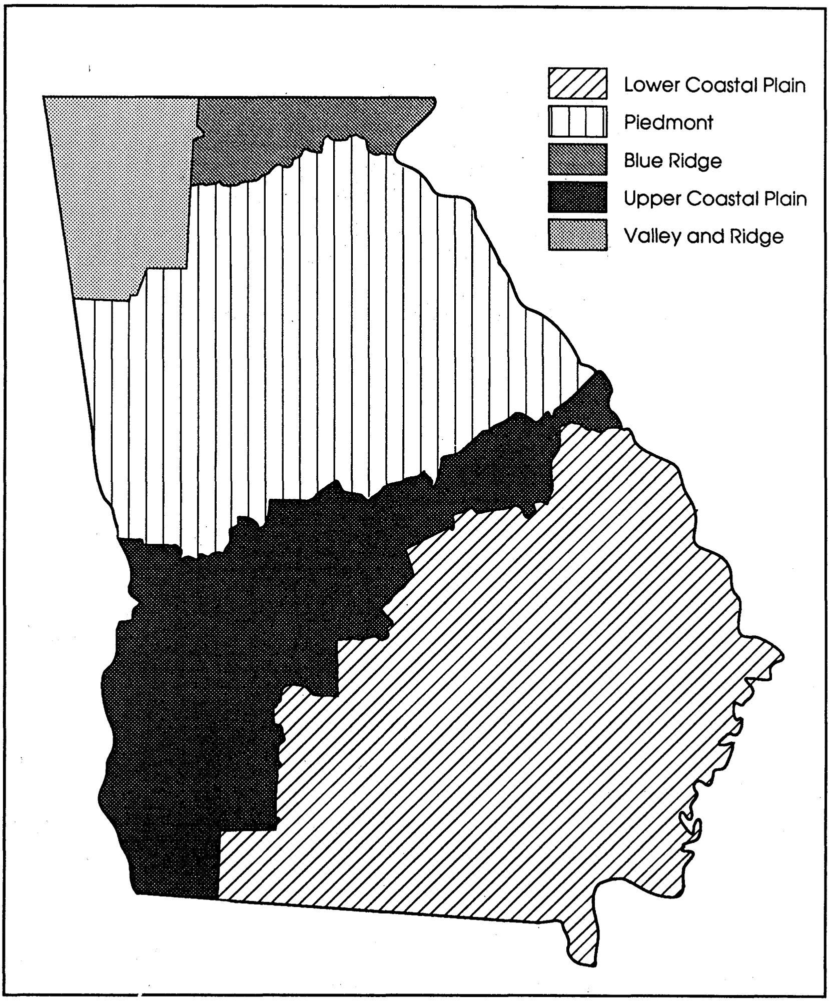

FIG. 1. Physiographic regions of Georgia.

type of system, the growth and mortality of individual trees in a stand are projected into the future by using a set of equations. The data base to derive these equations consisted of the 1980 Forest Service FIA data of Georgia, from the Southeastern Forest Experiment Station. Models were developed from these data to predict live crown ratio, annual diameter increment, mortality, and bole length. Many of the approaches used in modeling were new and/or differed from previous projection systems. For example, as a means of organizing the diversity of forest conditions, heavy use was made of cluster analysis. A more in-depth presentation of the modeling procedures may be found in Bolton and Meldahl *(2)*. It is important that these procedures are reviewed before using the projection system, because many of the models were empirically derived and may not perform well outside the range of the data.

MULTIPURPOSE FOREST PROJECTION SYSTEM FOR GEORGIA (GATWIGS)

The growth and mortality models have been implemented into the TWIGS framework. TWIGS was originally developed by the U.S. Forest Service North Central Forest Experiment Station *(1)*. This is a menu-driven program which allows the user to explore several silvicultural and economic alternatives. In its current version, this projection system is a PC-based program for IBM compatible machines with at least two floppy drives and 540K of memory.

Input

The data required to run this system are fairly straightforward and similar to that collected on a typical cruise. The table below is an example of a required input file (and is included as TREE.TXT on the data disk). This file may be created using any standard text editor (e.g., EDLIN, SPFPC). The file contains two types of records.

An Example Plot

J. Doe Tract	S.W.¼	1990	20	0	40	75.0	PIE
400	5.5	10.0		16.0			
491	5.7	10.0		10.0			
491	5.5	10.0		9.0			
110	7.1	10.0		28.0			
611	16.9	10.0		55.0			
611	7.4	10.0		25.0			
802	6.5	10.0		22.0			
802	4.3	10.0		0.0			
802	6.1	10.0		20.0			
802	14.3	10.0		36.0			
812	8.9	10.0		29.0			
812	5.8	10.0		17.0			
812	8.9	10.0		30.0			
812	3.5	10.0		0.0			
820	8.3	10.0		26.0			
521	1.7	10.0		0.0			
552	7.6	10.0		20.0			
621	8.3	10.0		30.0			
131	10.5	10.0		45.0			
131	9.7	10.0		41.0			

The first type of record is the "header" or plot record. The fields are defined as:

Columns	*Field*
1-16	Property ID
18-25	Stand ID
27-30	Current year
32-36	Current stand age
40	Plantation status (0 = no; 1 = yes)
44-45	Tree count (total number of stems listed in the input file)
49-50	Forest type
52-55	Site index[4] (base age = 50)
57-59	Region

Forest type codes closely follow those used by Forest Survey and are further defined in Appendix 1. Region is a three-digit code representing the physiographic region. These are defined as:

LCP = Lower Coastal Plain
UCP = Upper Coastal Plain
PIE = Piedmont
VAL = Valley and Ridge
BLU = Blue Ridge Mountains

The second type of record is the tree record. The fields for this record are defined as:

Column	*Field*
1-3	Species code
12-16	Dbh
26-30	Expansion factor (trees/acre represented by the stem)
40-44	Bole length to a 4-inch d.o.b. (optional)

Species codes follow those used by Forest Survey, and are further defined in Appendix 2. Bole length is an optional entry.

EXECUTING GATWIGS

Once the input file is created, TWIGS is fairly simple to execute. GATWIGS is designed to run off either a hard disk or two floppy drives. This system is distributed on two diskettes. The first diskette is known as the EXE disk and the second as the DATA disk. If the user is operating off a hard disk, then both diskettes should simply be copied into a directory. To run GATWIGS on a dual floppy machine, place the EXE disk in drive A and the DATA disk in drive B. Now set the DOS prompt for drive A (A:/>) if using

[4]Site index is a plot productivity value used for all species present.

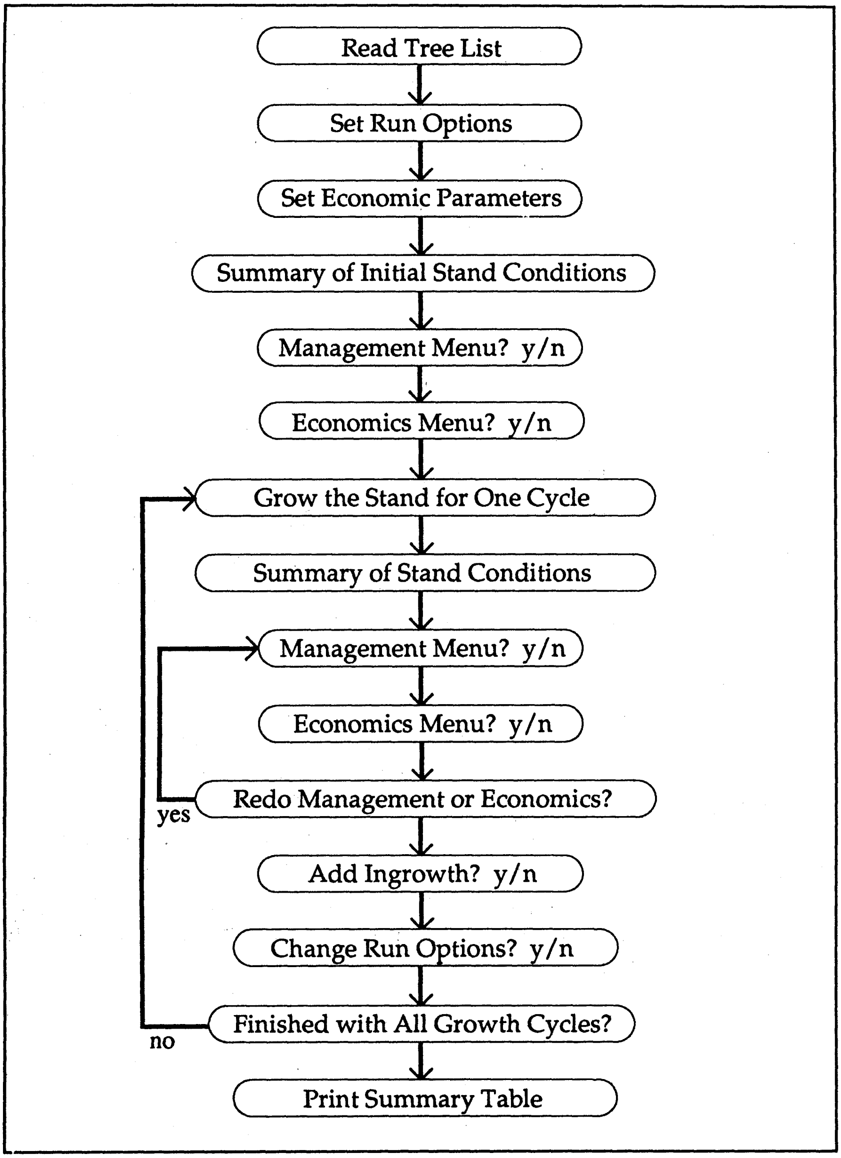

FIG. 2. Flowchart of a TWIGS projection *(6)*.

the floppy drive method or for the appropriate directory (C:/GATWIGS>) if using a hard disk. Then simply type GATWIGS and hit return. TWIGS will then prompt the user for additional information. Figure 2 is a flow chart of a TWIGS program. Most options and menus are straightforward. For a more in-depth exegesis on TWIGS the user is referred to the description of the original TWIGS program or to the latest documentation on TWIGS *(1,6)*.

It is important, due to the size of the output file, that when prompted for the location of the output file that it is assigned a location somewhere else than on the EXE disk. It is also important that DOS naming conventions are followed whenever such information is required. At most prompts, an example is given of the input required by TWIGS.

SUMMARY

After running TWIGS once the user will notice that many different options are available. These options should allow the user to explore myriad management strategies. The user is reminded that this projection system is based on a set of models, which have various assumptions. Information regarding the GATWIGS models and some of the known limitations is provided to the user at the start of each simulation. There are many reasons why these models may fail to accurately predict a given situation *(4)*. Therefore, it is important that users familiarize themselves with how the models were constructed and think about what is input and output. For example, the system will allow the user to input a 30-inch dbh dogwood tree. The system will also grow the tree and calculate volumes. However, this tree is well outside the range of the data and any results should be suspect. Model validation is an on-going process. Due to the nature of the data used in deriving the models, this is an important process. It is also an involved process *(3)*. Initial results suggest that overall the models adequately predict tree growth and mortality. Therefore, if used with some thought and caution, this projection system may prove to be a valuable tool.

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APPENDIX 1. FOREST TYPE DEFINITIONS

White Pine - Hemlock (Code 4)—Forests in which eastern white pine and hemlock, singly or in combination, comprise a majority of the stocking.

Loblolly Pine Plantation (Code 5)—Forests in which loblolly pine was artifically regenerated with acceptable survival and comprises a plurality of the stocking.

Shortleaf Pine Plantation (Code 6)—Forests in which shortleaf pine was artifically regenerated with acceptable survival and comprises a plurality of the stocking.

Longleaf Pine Plantation (Code 7)—Forests in which longleaf pine was artifically regenerated with acceptable survival and comprises a plurality of the stocking.

Longleaf Pine (Code 21)—Forests in which southern yellow pines, singly or in combination, comprise a plurality of the stocking, and in which longleaf pine contributes the most stocking of the pines.

Slash Pine (Code 22)—Forests in which southern yellow pines, singly or in combination, comprise a plurality of the stocking, and in which slash pine contributes the most stocking of the pines.

Loblolly Pine (Code 31)—Forests in which southern yellow pines, singly or in combination, comprise a plurality of the stocking, and in which loblolly pine contributes the most stocking of the pines.

Shortleaf Pine (Code 32)—Forests in which southern yellow pines, singly or in combination, comprise a plurality of the stocking, and in which shortleaf pine contributes the most stocking of the pines.

Virginia Pine (Code 33)—Forests in which southern yellow pines, singly or in combination, comprise a plurality of the stocking, and in which virginia pine contributes the most stocking of the pines.

Redcedar (Code 35)—Forests in which redcedar comprises a plurality of the stocking.

Pond Pine (Code 36)—Forests in which southern yellow pines, singly or in combination, comprise a plurality of the stocking, and in which pond pine contributes the most stocking of the pines.

Pitch Pine (Code 38)—Forests in which southern yellow pines, singly or in combination, comprise a plurality of the stocking, and in which pitch pine contributes the most stocking of the pines.

Oak-Pine (Code 40)—Forests in which hardwoods (usually upland oaks) comprise a plurality of the stocking, but in which pines comprise 25 to 50 percent of the stocking. (Common associates include gum, hickory, and yellow poplar.)

Oak-Hickory (Code 50)—Forests in which upland oaks or hickory, singly or in combination, comprise a plurality of the stocking, except where pines comprise 25 to 50 percent, in which case the stand would be classified oak-pine (Common associates include yellow-poplar, elm, maple, and black walnut.)

Chestnut Oak (Code 52)—Forests in which chestnut oak *(Quercus prinus)* comprises a plurality of the stocking.

Southern Scrub Oak (Code 57)—Forests in which blackjack, bluejack, turkey, dwarf post, and bear oak, singly or in combination, comprise a plurality of the stocking.

Oak-Gum-Cypress (Code 60)—Bottomland forests in which tupelo, blackgum, sweetgum, oaks, or southern cypress, singly or in combination, comprise a plurality of the stocking, except where pines comprise 25 to 50 percent, in which case the stand would be classified oak-pine (Common associates include cottonwood, willow, ash, elm, hackberry, and maple.)

Elm-Ash-Cottonwood (Code 70)—Forests in which elm, ash, or cottonwood, singly or in combination, comprise a plurality of the stocking (Common associates include willow, sycamore, beech, and maple.)

APPENDIX 2. SPECIES CODE - COMMERCIAL TREES

Yellow Pines

107	Sand pine	*Pinus clausa*
110	Shortleaf pine	*Pinus echinata*
111	Slash pine	*Pinus elliottii*
115	Spruce pine	*Pinus glabra*
121	Longleaf pine	*Pinus palustris*
123	Table-Mt. pine	*Pinus pungens*
126	Pitch pine	*Pinus rigida*
128	Pond pine	*Pinus serotina*
131	Loblolly pine	*Pinus taeda*
132	Virginia pine	*Pinus virginiana*

Other Softwoods

010	Fraser fir	*Abies fraseri*
043	Atlantic white-cedar	*Chamaecyparis thyoides*
060	Eastern redcedar	*Juniperus virginiana*
090	Red spruce	*Picea rubens*
129	White pine	*Pinus strobus*
221	Baldcypress	*Taxodium distichum* var. *distichum*
222	Pondcypress	*Taxodium distichum* var. *nutans*
241	Northern white-cedar	*Thuja occidentalis*
260	Eastern hemlock	*Tsuga canadensis*

Soft Hardwoods

313	Boxelder	*Acer negundo*
316	Red maple	*Acer rubrum*
317	Silver maple	*Acer saccharinum*
330	Buckeye	*Aesculus* spp.
460	Hackberry	*Celtis occidentalis*
555	Loblolly-bay	*Gordonia lasianthus*
580	Silverbell (in mts.)	*Halesia* spp.
601	Butternut	*Juglans cinerea*
611	Sweetgum	*Liquidambar styraciflua*
621	Yellow-poplar	*Liriodendron tulipifera*
651	Cucumbertree	*Magnolia acuminata*
652	Magnolia	*Magnolia* spp.
653	Sweetbay	*Magnolia virginiana*
691	Water tupelo	*Nyssa aquatica*

693	Blackgum (upland)	*Nyssa sylvatica*
694	Blackgum (lowland)	*Nyssa sylvatica*
731	American sycamore	*Platanus occidentalis*
740	Cottonwood	*Populus* spp.
762	Black cherry	*Prunus serotina*
920	Willow	*Salix* spp.
950	American basswood	*Tilia americana*
970	Elm	*Ulmus* spp.

Hard Hardwoods

311	Florida maple	*Acer barbatum*
318	Sugar maple	*Acer saccharum*
370	Birch (except yellow)	*Betula* spp.
371	Yellow birch	*Betula alleghaniensis*
400	Hickory	*Carya* spp.
491	Flowering dogwood	*Cornus florida*
521	Persimmon (forest grown)	*Diospyros virginiana*
531	American beech	*Fagus grandifolia*
540	Ash	*Fraxinus* spp.
552	Honeylocust	*Gleditsia triacanthos*
591	American holly	*Ilex opaca*
602	Black walnut	*Juglans nigra*
680	Red mulberry	*Morus rubra*
802	White oak	*Quercus alba*
804	Swamp white oak	*Quercus bicolor*
806	Scarlet oak	*Quercus coccinea*
812	Southern red oak	*Quercus falcata*
813	Cherrybark oak	*Quercus falcata* var. *pagodaefolia*
817	Shingle oak	*Quercus imbricaria*
820	Laurel oak	*Quercus laurifolia*
822	Overcup oak	*Quercus lyrata*
823	Bur oak	*Quercus macrocarpa*
825	Swamp chestnut oak	*Quercus michauxii*
826	Chinkapin oak	*Quercus muehlenbergii*
827	Water oak	*Quercus nigra*
830	Pin oak	*Quercus palustris*
831	Willow oak	*Quercus phellos*
832	Chestnut oak	*Quercus prinus*
833	Northern red oak	*Quercus rubra*
834	Shumard oak	*Quercus shumardii*

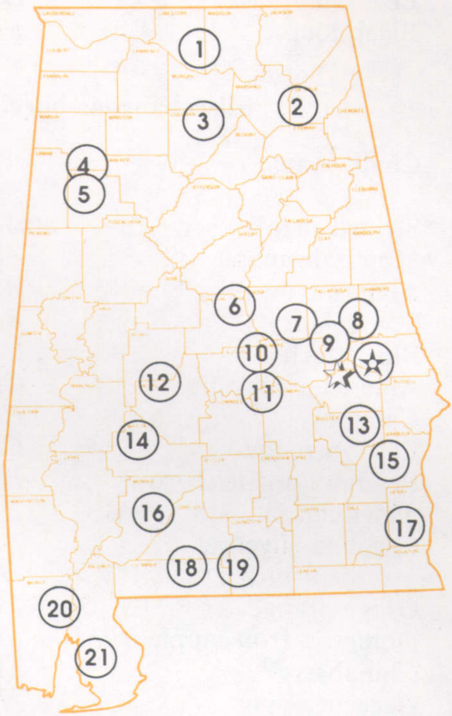
835	Post oak	*Quercus stellata*
837	Black oak	*Quercus velutina*
838	Live oak	*Quercus virginiana*
901	Black locust	*Robinia pseudoacacia*

Miscellaneous Species

310	Chalk maple	*Acer saccharum* var. *leucoderme*
315	Striped maple	*Acer pensylvanicum*
319	Mountain maple	*Acer spicatum*
341	Ailanthus	*Ailanthus* spp.
352	Serviceberry	*Amelanchier* spp.
391	Blue beech	*Carpinus caroliniana*
421	American chestnut	*Castanea dentata*
451	Catalpa	*Catalpa* spp.
471	Eastern redbud	*Cercis canadensis*
521	Persimmon (field grown)	*Diospyros virginiana*
548	American mt. ash	*Pyrus americana*
581	Carolina silverbell (except mts.)	*Halesia carolina*
641	Osage-orange	*Maclura pomifera*
660	Domestic fruit (apple etc.)	*Malus* spp.
661	Chinaberry	*Melia azedarach*
692	Ogeechee gum	*Nyssa ogeche*
701	Eastern hophornbeam	*Ostrya virginiana*
711	Sourwood	*Oxydendrum arboreum*
712	Royal paulownia	*Paulownia tomentosa*
721	Redbay	*Persea borbonia*
722	Planer-tree (water-elm)	*Planera aquatica*
760	Fire cherry	*Prunus pensylvanica*
807	Bluejack oak	*Quercus incana*
816	Bear oak	*Quercus ilicifolia*
819	Turkey oak	*Quercus laevis*
824	Blackjack oak	*Quercus marilandica*
840	Dwarf post oak	*Quercus stellata* spp.
841	Dwarf live oak	*Quercus virginiana* spp.
899	Other scrub oaks	*Quercus* spp.
931	Sassafras	*Sassafras albidum*
999	Other miscellaneous trees	-----

Alabama's Agricultural Experiment Station System
AUBURN UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

☉ Main Agricultural Experiment Station, Auburn.
☆ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Chilton Area Horticulture Substation, Clanton.
7. Forestry Unit, Coosa County.
8. Piedmont Substation, Camp Hill.
9. Plant Breeding Unit, Tallassee.
10. Forestry Unit, Autauga County.
11. Prattville Experiment Field, Prattville.
12. Black Belt Substation, Marion Junction.
13. The Turnipseed-Ikenberry Place, Union Springs.
14. Lower Coastal Plain Substation, Camden.
15. Forestry Unit, Barbour County.
16. Monroeville Experiment Field, Monroeville.
17. Wiregrass Substation, Headland.
18. Brewton Experiment Field, Brewton.
19. Solon Dixon Forestry Education Center, Covington and Escambia counties.
20. Ornamental Horticulture Substation, Spring Hill.
21. Gulf Coast Substation, Fairhope.