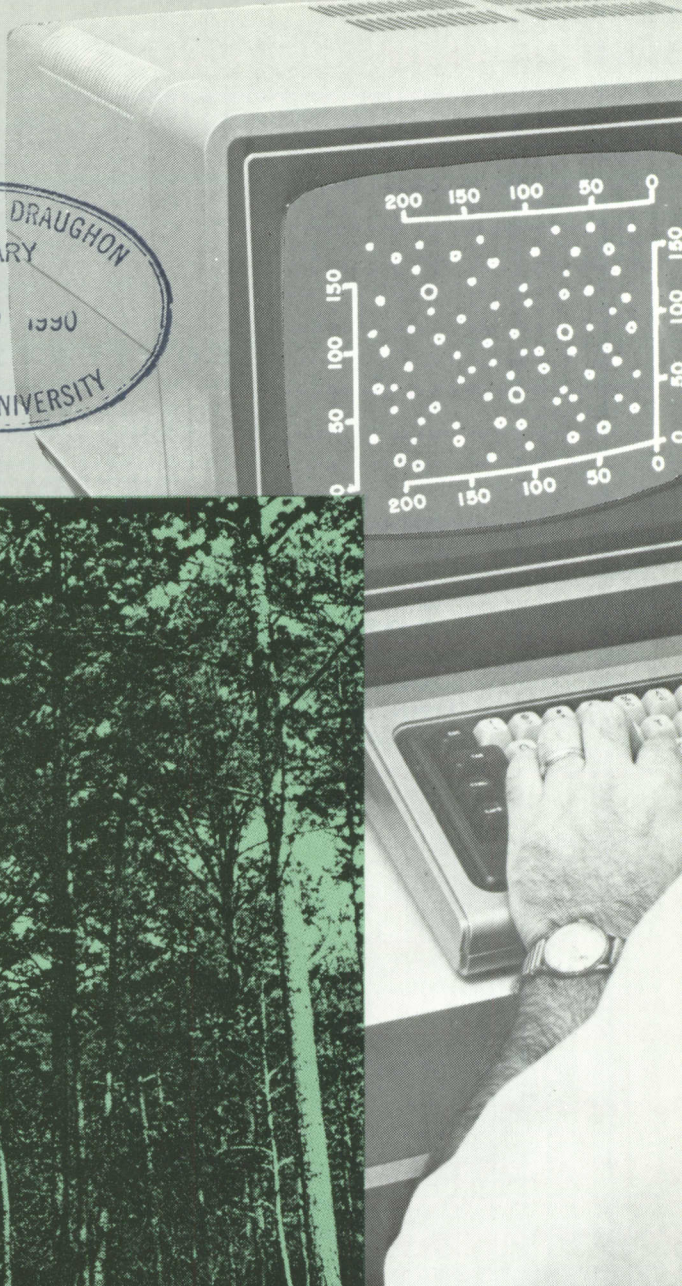
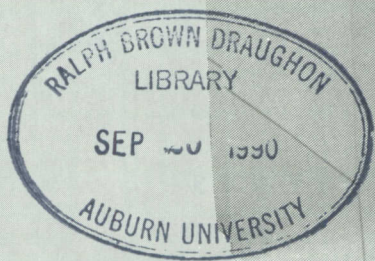


Bulletin 574
November 1985



A generalized plotting program to produce stand maps

Alabama Agricultural Experiment Station, Auburn University
David H. Teem, Acting Director, Auburn University, Alabama



C O N T E N T S

	<i>Page</i>
INTRODUCTION	3
PROGRAM APPLICATION	4
A. Data File	5
B. Plotting Parameters	5
C. Other Plotting Parameters	6
EXAMPLE PLOTS	7
SUMMARY	10
APPENDIX A. Computer Plotting: Basic Concepts	10
APPENDIX B. Program Listing	12

FIRST PRINTING 3M, NOVEMBER 1985

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

A GENERALIZED PLOTTING PROGRAM TO PRODUCE STAND MAPS

J. S. Conway, B. L. Lanford, B. J. Stokes, and W. D. Greene¹

INTRODUCTION

OF ALL THE TOOLS used by foresters, maps are among the most indispensable. One type of map which is becoming more popular is a stand map. Stand maps show the location of each tree on a plot of ground. Often tree diameter is drawn to scale and a tree identifying number may also be included.

Stand maps have several uses: (1) documenting tree locations within a permanent research plot, (2) illustrating spatial relationships of trees within a stand, (3) illustrating thinning treatments, (4) moulding input for interactive simulation programs, or (5) adding input for harvesting or growth and yield simulation.

Permanent field plots are often maintained by industry, government, or academic organizations for forest inventory and research measurements. Locating a tree which was previously measured is made easier with a stand map. Such a map should show tree location and any identifying number or species code.

Forest stands generally occur in one of three spatial arrangements, clumped, random or uniform. Clumped stands are typically found where seed tree or shelterwood methods of regeneration are used. Random stands arise from seed or sprout regeneration while uniform arrangement results in planted stands such as pine plantations. Stand maps quickly illustrate the differences in spatial arrangement present in various stands.

Stand maps can also illustrate the effect on a forest stand of different thinning methods (selective, third-row removal,

¹The authors are former Graduate Research Assistant of Forestry, Associate Professor of Forestry, Forest Engineer, Southern Forest Experiment Station, USDA Forest Service, and Graduate Research Assistant of Forestry.

etc.). Maps can also be used with interactive simulation programs which are becoming increasingly popular for analyzing thinning treatments. In addition, most numerical harvesting simulation packages rely on stand information which is easily illustrated with a stand map. Many growth and yield simulation programs utilize similar stand information, which could also be represented with a stand map.

While stand maps have many uses, they are time consuming to create by hand. To reduce the amount of time needed to produce a stand map, a general stand map plotting program was created.

PROGRAM APPLICATION

Most mainframe computer systems support some type of generalized plotting package. Often the package consists of a set of subroutines which perform a specific type of plotting function (e.g., draw a line, draw a symbol, etc.). These subroutines are called within a computer program in order to create a stand map or other complex graphic image. A more detailed discussion of plotting programs and their logic is found in Appendix A.

The plotting program presented in this publication is named PLOTSTND (for "Plot-stand"). It was written in FORTRAN-G for use on the IBM 3033 mainframe computer available at Auburn University. The plotter supported by this system is the Versatec-07 electrostatic plotter. While the program presented here is specific to this computer and plotter combination, the logic and structure of the PLOTSTND program should be applicable to any plotting system. Appendix B contains a program flowchart and code.

PLOTSTND is organized so that the user can quickly draw a plot of a study area which has been recorded in a data file. The format of data in the file will vary depending on the application, but the x- and y-coordinates and diameter at breast height (DBH) must be included. Tree number, species, and other variables also may be used. Before running the program, the user must specify the name of the data file to be used and set various plotting parameters within the program to create the desired plot. The program is then processed by the computer in a batch fashion. A discussion of each of the required inputs to the program follows.

Data File

The data file is specified within the job control language (JCL) statements of the program. The data file is specified on the following JCL statement which is found near the end of the program: //GO.FT10F001 DD DSN=jobcode.library.type(member),DISP=SHR. The words "jobcode.library.type(member)" are replaced by the name of the data file to be used. If the data are stored in a sequential file, the "(member)" portion is omitted.

Plotting Parameters

There are nine plotting parameters which should be specified by the user before using the program. The parameter values are changed within the program itself. Comment statements early in the program code explain the parameters, Appendix B. A brief description of each parameter follows.

SCLMAP defines the scale of ground distances on the plot. This number must be in map inches per actual foot of ground distance. Using a value of SCLMAP which is a fraction of 10 (e.g., 0.10, 0.05, etc.) allows convenient use of an engineer's scale for measuring distance.

DSCALE specifies the scale of tree diameters in map inches per actual DBH inch. It is often desirable to exaggerate tree diameter slightly in order to distinguish relative tree sizes. A DSCALE value of two times SCLMAP results in a six-fold exaggeration of DBH and is often useful.

HTNUM specifies the character height in inches for printing tree numbers and species codes beside each tree location. Setting HTNUM = 0.05 provides clear but unobtrusive labelling of each tree symbol.

TREEAC identifies the desired residual stand density for the plot. PLOTSTND will draw a grid overlay with TREEAC scaled blocks per acre on the plot. This feature provides a quick method for checking the number of trees remaining in a thinned stand. A stand which has been thinned to TREEAC trees per acre should have an average of one tree within each grid block. Specifying TREEAC = 0.0 will cancel the grid-drawing procedure for a plot.

THNDBH is used when thinning is performed within the plotting program. THNDBH specifies the minimum diameter of "leave" trees on the plot (i.e., all trees smaller than THNDBH will not be plotted). If thinning is not to occur within the

program, set THNDBH=0.0. This parameter must be used in conjunction with the ITHNOP parameter discussed below.

XWIDTH is the actual length in feet of the study plot. In order to efficiently use the Versatec's plotting space, XWIDTH should equal the longest plot side. (If the Y dimension is the longest dimension on the ground, the axes will be transformed within the program to generate an accurate plot.)

YWIDTH is the actual length in feet of the shorter side of the study plot. Because of limits on the paper sizes used with the Versatec plotter, the product of YWIDTH and SCLMAP should be less than 10 inches.

ISYMB is an integer parameter which specifies the information to be plotted within the plot. If ISYMB = 1, only tree symbols will be drawn at each tree location. If ISYMB = 2, the computer will plot tree symbols with tree number and species code numbers at each tree location. Tree number and species often clutter the appearance of a plot, therefore if they are not needed, ISYMB should be set equal to 1.

ITHNOP defines the type of data file being input into the program. For files which have been thinned by another program and have "cut" and "leave" codes for each tree, set ITHNOP = 1. For "raw" data files which are to be thinned by this program, set ITHNOP = 2. When ITHNOP = 2 and THNDBH = 0.0, a plot of all trees before thinning is drawn.

Other Plotting Parameters

Two plotting parameters are found within the JCL statements rather than within the program code. Both of these parameters are found within the following JCL statement: &PLOT SCALE=1.00 *YMAX=10.55 &END.

SCALE determines the global scale of the plot. For example, when SCALE = 2.0, the map size will be doubled, and when SCALE = 0.5, the map size will be halved. The default value for SCALE is 1.0. The value of YWIDTH \times SCLMAP \times SCALE should be less than 10.0 inches for single strip maps. When SCLMAP is not an even factor of 10 (0.333 for example), the axes notation on the plot will take on non-integer values and be rounded before plotting. By specifying SCLMAP = 0.5, and SCALE = 0.667, a map with a scale of 1.0 inch equals 30 feet will be produced with complete axes. The user should note that when the global scale is changed, the scale label on the plot will be in error by a factor of scale times.

***YMAX** defines the maximum width of the plot. As mentioned above, $YWIDTH \times SCLMAP$ must be less than or equal to 10.0 inches. This allows about half an inch along the map's edge for axis labels. Since the Versatec's paper is 10.55 inches wide, the default value for ***YMAX** is 10.55. If a map of greater width is desired, the parameter ***YMAX** must be increased in increments of 10.55 inches. Plotter output for larger map sizes will consist of two or more 10.55-inch wide strips which must be assembled to form a complete map. The value of $YWIDTH \times SCLMAP \times SCALE$ should **always** be less than ***YMAX** - 0.50.

EXAMPLE PLOTS

To illustrate the types of plots available and some of their possible uses, four examples are discussed. Each example plot is shown along with the plotting parameters needed to produce the plot with PLOTSTND. This should aid beginning users in becoming familiar with the program and its possible uses.

Figure 1 contains a stand map of a typical unthinned southern pine stand. Tree diameter is slightly exaggerated (3 times) so that a viewer can distinguish relative tree size. There are 594 trees per acre and row alignment is fairly well defined. Such a map would show the type of thinning to be performed or to illustrate how a stand appeared before thinning.

The previous stand is shown after thinning in figure 2. There are now 350 trees per acre and row alignment is more difficult to discern due to the reduced number of trees. Comparison of the two stand maps provides an effective illustration of the changes in a stand due to thinning.

Stand maps can also be used to represent a forest stand in an interactive simulation program, figure 3. The scale of tree diameters and ground distances are equivalent, allowing a scale model machine moved through the stand to accurately simulate spatial relationships present. This use of stand maps is relatively new, but has tremendous potential for use in analyzing logging problems.

A more traditional use of stand maps is for documenting tree locations within a permanent (or long-term) study plot. A stand map for such a purpose would show trees in their respective locations with their identifying numbers alongside, figure 4. This reduces the difficulty of finding the tree on return trips to the plot for data collection. If space permits on the stand map itself, it can provide an effective tally sheet for field work.

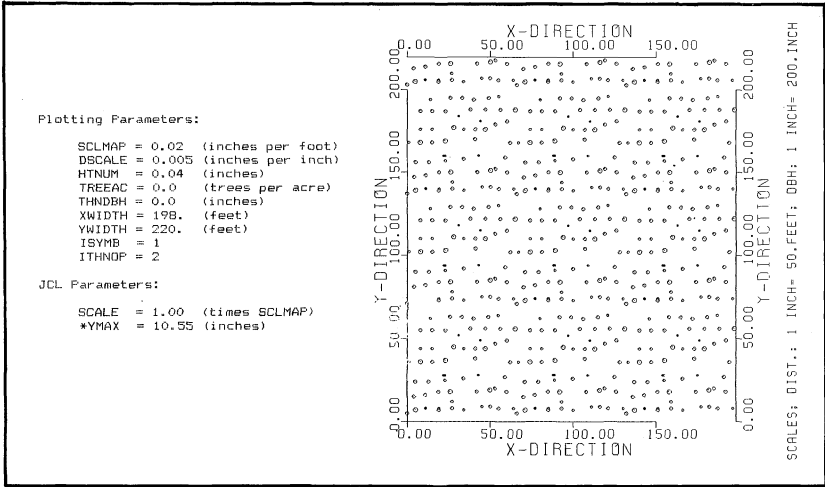


FIG. 1. Stand map of a typical unthinned stand.

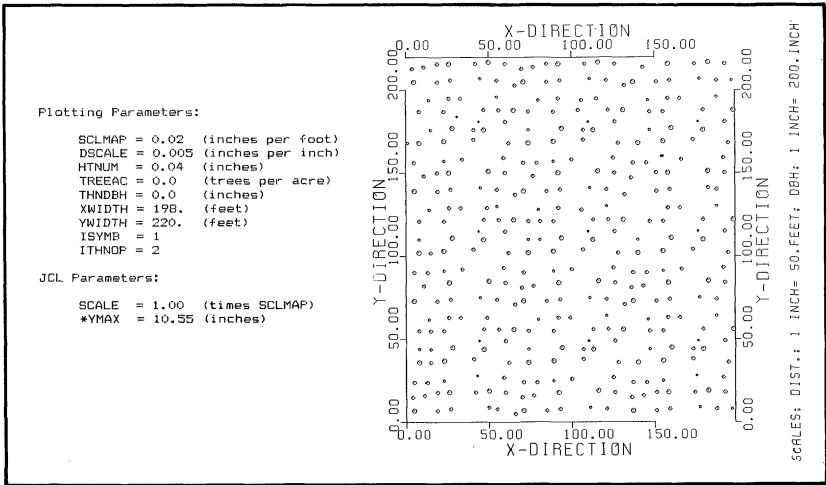


FIG. 2. Stand map of a typical thinned stand.

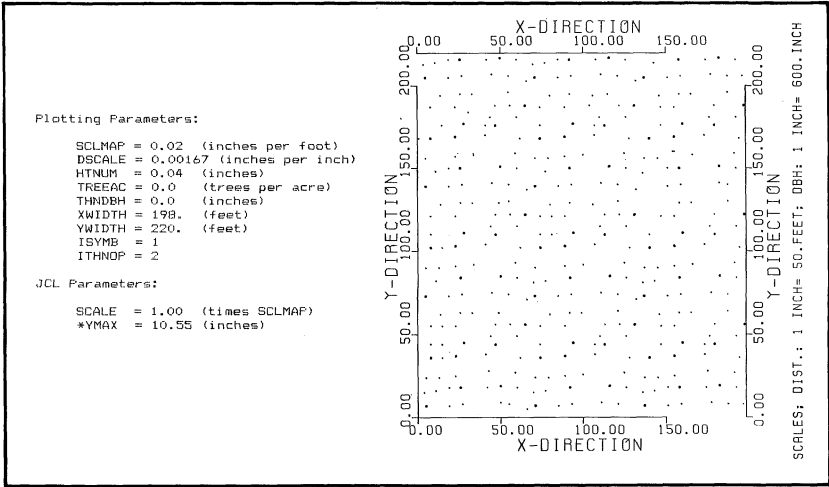


FIG. 3. Stand map used in interactive machine simulation.

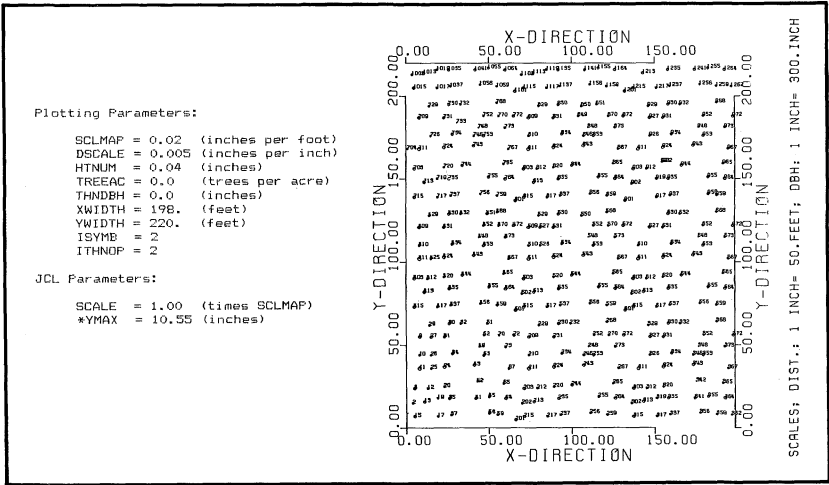


FIG. 4. Stand map used for documentation of a study plot.

SUMMARY

Maps of forest stands have a variety of uses. Computer generated stand maps can be used to keep records of how a plot's composition changes over time. Once a map has been constructed, it can be quickly updated. The stand map also can be used for data input in conjunction with a digitizer. More accurate distance measurements are also possible with computer-drawn maps. Maps can often save expensive trips to the field. Applications have also been developed recently for using stand maps as an integral part of machine modelling with interactive simulation.

With the availability of sophisticated graphics software on today's microcomputers, the formation of stand or plot maps is a procedure that most managers or researchers can use to make their work more efficient.

APPENDIX A

Computer Plotting: Basic Concepts

This discussion of plotting concepts is included to familiarize computer users with basic computer graphics. This is not a "how-to" plotting guide; rather it is an overview of the plotting process. Those users who may wish to modify the PLOTSTND program or write their own plotting program may want to review these general ideas.

The Graphics Package

Most computer graphics packages use a planar Cartesian coordinate system (perpendicular X- and Y-direction) as the operating scheme for plotting. The software will define the logical origin, axes convention, and plotting boundaries for ordinary plot generation. These plotting boundaries define what is referred to as the plotting "window." The user may specify plotting parameters and plotting window sizes other than the system-provided defaults when a special need arises. Extra JCL statements are required to change these default values.

To draw diagrams using the computer graphics system, a program of plotter pen instructions is required. These instructions specify the X and Y coordinates to which the pen is to move from its present position. Whether the pen is to be up or down during the move must also be specified. The

programmer must also instruct the pen to either return to the plotting origin or to remain at the present location after each move is made.

The program of pen instructions must conform to the requirements of the plotting software. The programmer must make sure that the pen stays within the plotting window during all moves. Otherwise, lines may be unplottable or partially clipped if they fall outside the plotting window.

When using the IBM-Versatec plotting system or any computer combination, system subroutines are available which greatly reduce the amount of programming required. These subroutines are sets of plotter pen directions which perform the most commonly used plotting functions, such as drawing axes, plotting graphs and bar charts, and printing labels and scale values. In the case of the IBM-Versatec plotting system, plotting subroutines may be accessed by entering the FORTRAN CALL statement: CALL subroutine name (argument).

In the position labeled "subroutine name," the name of the subroutine being used is entered. Subroutines used in the PLOTSTND program include AXIS and SYMBOL. The "argument" of the subroutine is the set of parameters which dimension the plotting function. For example, in the argument for the CALL AXIS subroutine, the user must specify the axis starting coordinates, the axis label, the number of characters in the axis label, the length of the axis, the angle at which the axis line is to be drawn, the first value used in axis annotation, and the number of data units per map inch. A complete description of each plotting subroutine used in PLOTSTND may be found in the user guides for AUPLOT and VTEC PLOTTER available from the Division of University Computing at Auburn University.

APPENDIX B

Listing of PLOTSTND.FORT

```

//USERID# JOB (USERID,BIN),'USER NAME',MSGCLASS=P,
NOTIFY=USERID#
/*ROUTE PRINT LOCAL
/*JOBPARM TIME=05,LINES=20K
//STEP EXEC FTGVCLG
//FORT.SYSIN DD *
C
C THIS IS A PROGRAM TO PLOT TREE LOCATIONS AND
DIAMETERS ON THE AUCS VERSATEC PLOTTER.
C
C *PLOTTING PARAMETER DEFINITIONS :
C
C (SCLMAP) THE MAP SCALE IS ENTERED AS A FRACTION
(INCHES PER FOOT) .
C (DSCALE) DIAMETER SCALE IS ENTERED AS A FRACTION
(INCHES PER INCH) .
C (HTNUM) HEIGHT OF PRINTED TREE & SPECIES CODE
NUMBERS (INCHES) .
C (TREEAC) TREES PER ACRE FOR THE GRID DENSITY.
C **NOTE: 1. SET (TREEAC)=0.0 TO DELETE GRID PLOTTING
OPTION.
C (THNDBH) MINIMUM DIAMETER OF "LEAVE" TREES.
C (XWIDTH) THE X-DIRECTION DIMENSION OF ACTUAL
STAND (FEET) .
C (YWIDTH) THE Y-DIRECTION DIMENSION OF ACTUAL
STAND (FEET) .
C **NOTE: 1. (XWIDTH SHOULD BE THE LONGER OF THE
TWO DIMENSIONS.
2. (YWIDTH*SCLMAP) MUST BE .LE. 10.0 .
C (ISYMB) =1 FOR PLOTTING TREE SYMBOLS ONLY.
C =2 FOR PLOTTING TREE SYMBOLS WITH
NUMBERS.
C (ITHNOP)=1 FOR SOURCE FILES ALREADY THINNED.
C =2 FOR SOURCE FILES NOT THINNED,
THINNING IN THIS PROGRAM.
C
C
C
SCLMAP=0.10
DSCALE=0.00833
HTNUM=0.05
TREEAC=0.0
THNDBH=0.0
XWIDTH=66.
YWIDTH=66.
ISYMB=1
ITHNOP=2
C

```

```

C *COUNT # OF TREES IN DATA SET.
C
  ITTLTR=0
  DO 10 I=1,100000
  READ (10,100,END=20)
  ITNUM,DBHT,ISP,YLOC,XLOC,TLHT,LMDIA,FLAG
  ITTLTR=ITTLTR+1
10 CONTINUE
20 CONTINUE
  REWIND 10
  WRITE (6,101) ITTLTR
101 FORMAT(1X,'NUMBER OF TREES IN FILE = ',I6)
C *DRAW A SCALED AXES SYSTEM IN THE CORRECT
  DIRECTION ON THE VERSATEC'S PLOTTING PAPER.
C
C *THE FOLLOWING STATEMENTS ARE MARGINS, DO NOT
  CHANGE.
C
  XSTART=0.5
  YSTART=0.5
C
C *INITIALIZE PLOTTING.
C
C
C CALL PLOTS (0,0,0)
C
  XLEN=XWIDTH*SCLMAP
  YLEN=YWIDTH*SCLMAP
  XAX=XLEN+XSTART
  YAX=YLEN+YSTART
  DVAL=1/SCLMAP
  DBHV=1/DSCALE
  XX=XLEN+0.6
C
C *THIS 'CALL PLOT' COMMAND PUTS THE LOGICAL
  CENTER ON THE MARGIN.
C
  CALL PLOT (XSTART,YSTART,-3)
C
C *THE 'CALL AXIS' COMMAND DRAWS THE AXES TO
  SCALE.
C
  CALL AXIS (0.0, 0.0,'X-DIRECTION', 11,YLEN,90.0,0.0,DVAL)
  CALL AXIS (XLEN, 0.0,'X-DIRECTION',-
    11,YLEN,90.0,0.0,DVAL)
  CALL AXIS (0.0, 0.0,'Y-DIRECTION',-11,
    * XLEN, 0.0,0.0,DVAL)
  CALL AXIS (0.0, YLEN,'Y-DIRECTION', 11,XLEN,
    0.0,0.0,DVAL)
  CALL SYMBOL ( XX,0.0,0.10,
    * 'SCALES; DIST.: 1 INCH= FEET; DBH: 1

```

```

INCH= INCHES',
* 90.0,55 )
CALL NUMBER ( XX,2.3,0.10,DVAL,90.0, 0 )
CALL NUMBER ( XX,4.5,0.10,DBHV,90.0, 0 )
C
IF ( TREEAC .EQ. O.O ) GO TO 80
GSIZE=SQRT(43560/TREEAC)
IXGRID=(XWIDTH/GSIZE)+1
IYGRID=(YWIDTH/GSIZE)+1
GRDSZE=GSIZE*SCLMAP
YGCNTR=(GRDSZE/2*(-1))+YSTART
C
C *THE 'CALL GRID' COMMAND DRAWS A TREE PER ACRE
GRID OVERLAY.
C
CALL GRID
(0.0,YGCNTR,IXGRID,GRDSZE,IYGRID,GRDSZE,-30584)
C
80 CONTINUE
C
DO 200 I=1,ITTLTR
READ (10,100)
ITNUM,DBHT,ISP,YLOC,XLOC,TLHT,LMDIA,FLAG
100 FORMAT(13,F4.1,I3,F4.0,F4.0,F4.0,F4.1,F4.0)
C
C *TRANSFORMATIONS FOR PLOTTING ARE WRITTEN
HERE.
C
X = YLOC
IF (XLOC .GT. 0 ) GO TO 90
Y= ABS(XLOC)+50.0
GO TO 95
90 Y=50.0-XLOC
95 CONTINUE
TRNUM=ITNUM
IF ( X .GT. XWIDTH ) GO TO 200
IF ( Y .GT. YWIDTH ) GO TO 200
IF ( ITHNOP .EQ. 1 ) GO TO 111
IF ( DBHT .GT. THNDBH ) GO TO 110
FLAG=1
GO TO 111
110 CONTINUE
FLAG=0
111 CONTINUE
C
XDIST=X *SCLMAP
YDIST=Y *SCLMAP
DSIZE=DBHT*DSCALE
C
C *THE 'CALL NUMBER' COMMAND DRAWS THE TREE
C NUMBER AND SPECIES CODE AT THE TREE LOCATION.
C

```

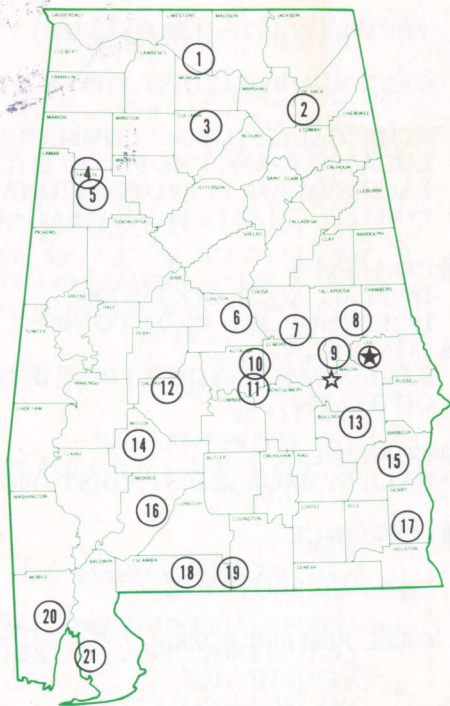
```

      IF ( ISYMB .EQ. 1 ) GO TO 195
      CALL NUMBER (XDIST,YDIST,HTNUM,TRNUM,0.0,-1)
      SPCODE=ISP
C
      YDSTN=YDIST-(1.25*HTNUM)
C
      CALL NUMBER (XDIST,YDSTN,HTNUM,SPCODE,0.0,-1)
C
C *THE 'CALL SYMBOL' COMMAND PLOTS THE TREE
  LOCATIONS ON THE PLOTTING PAPER. THE SIZE OF
  EACH SYMBOL IS PROPORTIONAL TO THE TREE DBH.
C **NOTE: 1. TREES WITH (FLAG=0) ARE 'LEAVE' TREES.
C
195 CONTINUE
      IF (FLAG .EQ. 0) GO TO 199
      IF (ITHNOP .EQ. 1) GO TO 199
198 CONTINUE
      CALL SYMBOL (XDIST,YDIST,DSIZE,3,0.0,-1)
      GO TO 200
C
199 CONTINUE
      CALL SYMBOL (XDIST,YDIST,DSIZE,1,45.0,-1)
C
200 CONTINUE
C
C END ALL PLOTTING
C
      CALL PLOT (0.,0.,999)
C
C
      STOP
      END
//GO.PLOTPARM DD *
  &PLOT SCALE=1.00 *YMAX=10.55 &END
//GO.FT10F001 DD DSN=FYL56DG.STAND.MAP(S170PL9),
  DISP=SHR
//GO.SYSIN DD DUMMY
//

```

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.