Users Guide to ACORn:
A Comprehensive Ozark Regeneration Simulator

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ACORn is a computer program that can help forest managers predict the number and species of trees that will regenerate following harvest in upland oak stands in the Ozark Highlands of Missouri and adjacent States (fig. 1). The program predicts the development of the most important hardwood species in the Ozark Highlands including the oaks, hickories, blackgum, sassafras, and flowering dogwood. ACORn predicts the expected height or diameter distributions of major trees species at 5, 10, and 21 years after complete overstory removal. ACORn also predicts stocking values by species and diameter class at age 21. To make these predictions, ACORn requires an inventory of the advance reproduction (trees <1.6 inches d.b.h.) and the overstory (trees ≥1.6 inches d.b.h.) before final harvest as well as information on site quality.

The models used in ACORn are based on more than 20 years of data from research plots in the region (Dey 1991). The models used in ACORn:

- assume that the overstory is completely removed shortly after the inventory is made;
- can be applied to clearcutting, shelterwood, and group selection methods;

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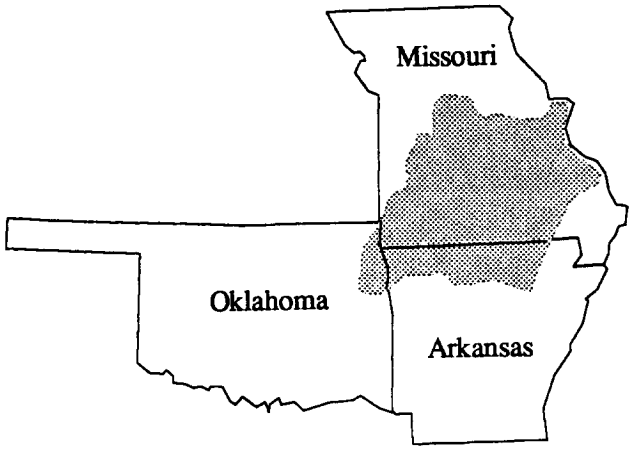


Figure 1.—*The Ozark Highlands (shaded area).*

- may not accurately predict the development of reproduction in small openings, e.g., those less than about 0.5 acres, due to the large "edge effect" associated with those openings;
- should not be applied to stands where tree species other than those listed in Appendix 1 are important members of the overstory or advance reproduction, or where they are expected to become important after final harvest;
- do not estimate the contribution to regeneration of stump sprouts originating from overstory blackgum, sassafras, or dogwood;
- were developed for the Ozark Highlands—their performance outside of this region has not been tested.

The theory and methodology for ACORn are presented by Dey (1991) and Dey and others (1996).

SYSTEM REQUIREMENTS

ACORn (version 2.0) is written in Borland Pascal version 7.0 and is available on diskette from:

North Central Forest Experiment Station
1-26 Agriculture Building
University of Missouri
Columbia, MO 65211
Phone: (573) 875-5341.

ACORn can be used with:

- IBM-compatible personal computers, 386 or faster, running DOS,
- color or monochrome monitors with a VGA graphics card,
- a minimum of 640K RAM,
- a keyboard or mouse (optional), and
- user-generated data input files.

When only 640K RAM is available, the maximum number of input trees that can be used is 5,000. As the amount of RAM increases above 640K, the number of input trees that can be used increases. ACORn does not require a math coprocessor.

User-generated data input files must be created in another software program such as a word processor or spreadsheet, or a DOS text editor.

NOTE: ACORn will always run under DOS outside of WINDOWS. ACORn will not run under the DOS shell in WINDOWS 3.1, but will run under the DOS shell in WINDOWS 95.

DISKETTE CONTENTS

The ACORn diskette contains the following files:

- ACORN.EXE - the program file,
- STUMP1.TXT - a sample input data file for a preharvest inventory of the overstory,
- ADREP1.TXT - a sample input data file for a preharvest inventory of the advancereproduction,
- SOURCE.EXE - the program source code, which is saved in a self-extracting archive file,
- EGAVGA.BGI - the graphics driver file, and
- RTM.EXE and DPMI16BI.OVL - memory managers used by ACORn.

PROGRAM INSTALLATION

Floppy Drive:

To run the program directly from a floppy drive, place the program disk in the drive, move to the floppy drive, and at the DOS prompt (A>) type ACORN, i.e.,

```
A> ACORN
```

(assuming the program disk is in A drive). Strike the ENTER key to load the program. Unless you specify otherwise during the running of ACORn, all output data files will be stored on the diskette that is loaded in the A drive. Eventually this may completely fill the floppy disk space. When this occurs, future program runs are possible, but the output data files will be lost. Therefore, we recommend that you load the ACORn program on the hard drive.

Hard Drive:

To copy the ACORn program files to a hard disk, create a new subdirectory (e.g., ACORn)

```
C:\ACORN
```

and copy all files on the ACORn program disk into the new subdirectory. To do this, place the program disk in the appropriate drive (e.g., A drive), and at the DOS, prompt type:

```
A> COPY A:*.* C:\ACORN
```

The following files must be in the same directory for the proper execution of the program: (1) RTM.EXE, (2) DPMI16BI.OVL, (3) EGAVGA.BGI, and (4) ACORN.EXE.

HOW TO RUN ACORn

Quick Start

To run the ACORn program, move to the subdirectory where ACORn is located, type ACORN at the DOS prompt, and strike the ENTER key. This loads the program and displays the ACORn title screen. Striking the ESC key any time during the creation of the title screen will produce the main menu screen. Striking the left mouse button or any key other than the ESC key will clear the title screen only after it is fully displayed.

Use the up/down arrow keys or the mouse to highlight specific menu items. The ENTER key or the left mouse button is used to make the desired menu selections. When default values are changed (e.g., height or diameter class intervals), or when new information (e.g., input or output data file names) is input, the ENTER key is used to accept the information.

Specify the stump sprout (overstory) and advance reproduction files by selecting **Input** from the main menu. Use **Output** to specify where output data files will be stored. Start the simulation by selecting **Run** from the main menu.

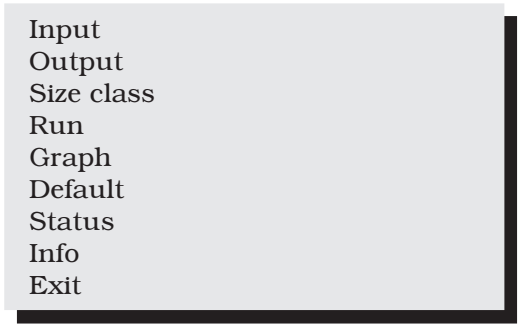
You can view graphical and tabled output on the screen by selecting **Graph** from the main menu. In the **Graph** mode, menus are provided that will allow you to control what is displayed on the screen. Use **Plot** to create a graph or table of future height or diameter distributions at specified stand ages for all species, individual species, or a group of species.

A hardcopy of the output data file can be produced by printing the appropriate file from DOS after exiting the ACORn program. More detailed descriptions of the individual menus are presented below.

To verify proper installation and execution of ACORn, use the sample input data files provided on the program diskette. The contents of these files (listed in Appendices 2 and 3) were used to reproduce the output shown in Appendices 4 or 5.

MAIN MENU

The program is menu-driven. The main menu is shown below.



A help line displayed as a header on the main menu screen briefly describes each main menu item. Use the up/down arrow keys or the mouse to highlight and select menu items. You can leave the program at any time by highlighting **Exit** and striking the ENTER key or the left mouse button.

Input

To specify the data file(s) to be used, highlight **Input** and strike ENTER or the left mouse button. This displays the menu shown below.

The stump sprouting data file is a preharvest inventory of the overstory (trees ≥1.6 inches in d.b.h.). The advance reproduction data file is a preharvest inventory of trees with diameters < 1.6 inches d.b.h.

The following table summarizes the output that can be generated by the program.

When the input data files are...	Possible output tables (for all trees and by species) include...
Stump sprout inventory only (trees ≥1.6 inches d.b.h.)	Height distribution of stump sprouts at age 5; D.b.h. distribution of stump sprouts at age 10; D.b.h. distribution of stump sprouts at age 21.
Advance reproduction inventory only (trees <1.6 inches d.b.h.)	D.b.h. distribution of advance reproduction at ages 10 and 21; Stocking distribution of advance reproduction at age 21.
Stump sprout inventory and Advance reproduction inventory	Height distribution of stump sprouts at age 5; D.b.h. distribution of stump sprouts and advance reproduction, individually and combined, at ages 10 and 21; Stocking distribution of stump sprouts and advance reproduction, individually and combined, at age 21.

The input data files are described in more detail on page 7. A sample of each data file is provided on the program diskette and in Appendices 2 and 3.

Highlight your choice of file type and strike the ENTER key or the left mouse button to display the menu below.

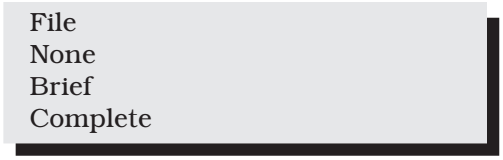
Enter a file name, e.g., ADREP1.TXT, and strike the ENTER key. (Note: Any time new information is input in ACORn, or default values are changed, the ENTER key must be used to register the changes). If the file does not reside in the ACORN subdirectory, you must specify the complete path to the file. For example: C:\ASCII\ADREP2.DAT. Repeat the above procedure to enter the name of the other file type.

Input file data lines with missing information or typing errors are treated as error lines. These lines are excluded from any calculations. Error lines not included in the calculations are saved in an output file that is identified in the warning message given during the loading of input files. The ACORn program can still be executed provided there is one valid tree in the data file. Details of the input data file formats are given on page 7.

To close the submenu and return to the main menu, position the cursor on the main menu and strike the left mouse button once, or strike the ESC key once.

Output

Select the desired type of data output by highlighting **Output** and striking the ENTER key or the left mouse button. This displays the menu shown below.



Choose from among **File**, **None**, **Brief,** or **Complete**. The menu item selected appears in red on color monitors and in dark lettering on monochrome monitors. If no selection is made, the program defaults to the **Brief** output. After selecting output type, return to the main menu by striking the ESC key or the left mouse button with the cursor positioned in the main menu box.

ACORn automatically names and saves each output data file created by running the program unless the **None** option is selected. File names default to RESULT00.DAT, RESULT01.DAT, etc., which are automatically saved to the ACORn directory. For example, if the last output data file was RESULT05.DAT, then the new output file will be named RESULT06.DAT. So, selecting **File** allows you to assign a different output file name and direct output to any directory or drive. Selecting **None** by striking the ENTER key or the left mouse button cancels the automatic file naming and saving process.

> **Note**: The output from multiple program runs are stored by appending the results to the last output data file designated. If the default output data file was used at program startup, the results from multiple runs will be stored in the default output data file selected by ACORn. Otherwise, the results from each new program run are stored in the user-designated data file by appending output files in the order that they are run in ACORn. If new input data files are entered and the results are to be stored in a separate output data file, then the new output data file must be identified using the **Output** option from the main menu before running the simulation.

Details about program output are presented in a later section.

Size Class

The **Size class** option facilitates changing the tree size class settings for graphical and tabular output of tree diameter and height distributions. The two options are shown below.

Highlight either menu item and strike the ENTER key or the left mouse button to display the menu prompt and specify the size class intervals desired. The default values are 1-inch d.b.h. classes and 1-foot height classes. Height

class intervals are restricted to the range from 0.25 to 10.0 feet. Diameter class intervals are restricted to the range from 0.1 to 10.0 inches. After selecting the new size class interval, strike the ENTER key to save the new settings.

Run

To run the ACORn program, highlight **Run** and strike the ENTER key or the left mouse button.

Graph

Use this option to initiate the **Graph** subroutine after the ACORn program has processed the input data. In this mode, graphical and tabular output can be viewed. A number of selections can be made to control what is displayed and summarized in the graphs and tables. Submenus are accessed by highlighting the desired **Graph** menu item using the mouse or arrow keys and striking the left mouse button or the ENTER key. A help line at the top of the **Graph** screen provides brief descriptions of each menu item. The following options are available from the menu bar displayed at the top of the **Graph** screen.

Species: The species menu contains a list of species for which graphical and tabular output can be presented. Species that occurred in the input data files are highlighted in bold in this species list. The species names in bold type are ones that can be displayed in the graphical or tabular output. The default is **All**, which will produce a plot or list of diameter, stocking (table output only), or height distributions for all species combined. To select individual species, highlight the species name using the mouse or the arrow keys. Striking the left mouse button or the ENTER key causes a double arrow to appear to the left of the name. The species is now selected for display.

To unselect a species, highlight the name with the mouse or arrow keys and strike the left mouse button or ENTER key. A group of species may be chosen by selecting multiple species names together. The resulting stocking, height, or diameter distribution will represent the whole group, not the individual species.

```
>> All
   Other
   Dogwood
   Sassafras
   Hickory
   Blackgum
   White oak
   Post oak
   Blackjack oak
   Black oak
   Scarlet oak
   S. red oak
   N. red oak
   Oak
```

Type: The type menu can be used to select the type of reproduction for plotting, i.e., stump sprouts, advance reproduction, or all reproduction. Menu options are shown below.

```
>> Total
   Stump sprouting
   Advanced reproduction
```

The default is **Total**, which presents combined diameter distributions of both stump sprouts and advance reproduction for all species, a single species, or a species group depending on the selection made in the **Species** menu. Use the mouse or arrow keys to highlight the type of reproduction to be plotted and strike the left mouse button or the ENTER key to select a specific type of reproduction. To unselect a type of reproduction, highlight the menu item and strike the left mouse button or the ENTER key.

Distribution: This menu can be used to select one of three types of size distributions for plotting: height at stand age 5, diameter at stand age 10, or diameter at stand age 21. The menu options are shown below.

```
   Height 5
   Diameter 10
>> Diameter 21
```

The diameter distribution at stand age 21 is the default. Height distributions at stand age 5 are available only for stump sprout reproduction. Both of the diameter distributions can be used for stump sprout, advance reproduction, or all reproduction types combined. To select a menu item, highlight the desired

distribution using the mouse or arrow keys and strike the left mouse button or the ENTER key. To unselect a menu item, highlight the item and strike the left mouse button or the ENTER key.

Crown Class: The crown class menu can be used to display the entire diameter distribution, or portions of it at stand ages 10 or 21. The menu options are shown below.

```
    Codominant
    Intermediate
>> All
```

The default is **All**, which produces a plot or list for the entire diameter distribution at stand age 10 or 21. Selecting **Codominant** results in the plotting or listing of all reproduction $\geq$ 3.8 inches d.b.h. At stand age 21, most trees $\geq$3.8 inches d.b.h. are in the codominant and dominant crown classes (Dey 1991). Selecting **Intermediate** results in the plotting of all reproduction $\geq$ 2.6 inches d.b.h. At stand age 21, most trees $\geq$2.6 inches d.b.h. are in the intermediate and larger crown classes (Dey 1991). These crown class options may be useful in identifying only that portion of the diameter distribution that represents **acceptable growing stock**. To select a specific item on the crown class menu, highlight the item using the mouse or arrow keys and strike the left mouse button or the ENTER key. To unselect an item, highlight it and strike the left mouse button or the ENTER key.

Display: This menu gives you a choice between graphical or tabular screen outputs of the species, reproduction type, distribution type, and crown class selections made in the preceding graphical menus. The menu is shown below.

```
>> Graph
   Table
```

The default is **Graph**. In both the **Graph** and **Table** screen outputs, the numbers of trees by height or diameter class at the specified stand ages are presented for the whole stand and for the individual species or species group previously selected. To select a specific item on the display menu, highlight the item using the mouse or arrow keys and strike the left mouse button or the ENTER key. To unselect an item, highlight it and strike the left mouse button or the ENTER key.

Plot: Selecting **Plot** presents either a graph or table of future size distributions based on the previous selections made in the **Species, Type, Distribution, Crown Class,** and **Display** menus. In the graph mode, the blue bars (on color monitors) represent numbers of trees by size class for the whole stand, i.e., all species combined. When an individual species or a species group has been selected in the **Species** menu, the blue bars represent the whole stand and the red bars represent the species or species group. Plots of height distributions at stand age 5 represent only stump sprout reproduction. Height and diameter class intervals correspond to those selected in **Size Class** from the main menu.

> **Note**: If the height or diameter class is small (e.g., 0.9 feet or 0.1 inches), the size classes are merged in both the graph and table screen displays because the screen display is limited to a maximum of 25 classes. However, the output files saved on disk display future size distributions by the specified class intervals.

After plotting a graph or displaying a table, you may change any one of the previous menus in the **Graph** subroutine. View the new selections by selecting the appropriate output type, i.e., graph or table and selecting **Plot**. Some selections in the **Graph** mode may result in "illegal" combinations of settings (e.g., selecting advance reproduction on the **Type** menu and height at age 5 on the **Distribution** menu). Plotting the graph or displaying the table is not possible in these situations (see the table on page 3 for permissible combinations). Also, if the default selection in any one of the **Species, Type, Distribution, Crown Class,** or **Display** menus is "unselected" without choosing an alternative menu item, selection of **Plot** results in an error. In these instances, the following warning is displayed.

```
Illegal or incomplete combination of settings
        make another selection
```

Quit: This option is used to exit the **Graph** subroutine and return to the main menu.

Default

This main menu option is used to save any changes to the default settings made during the current session. This may be useful if the changes will be used in future program runs. The menu options are listed below.

```
Save
Do not save
```

The default is **Do not save**. Unless you select the **Save** option, any changes made to other default settings will be lost when you leave the current program session.

Status

This main menu option provides a list of the current settings for input data path/filename, diameter and height size class values, and output path/filename and type. This option can be selected at any time. The following information window is displayed if **Status** is selected immediately upon entering the ACORn program:

```
Input file on stump
   sprouting              :NONE
Input file on advance
   reproduction           :NONE
DBH size class [in]       :1
Height size class [ft]    :1
Output file name          :C:\Result00.dat
Output type               :BRIEF
```

The information is automatically updated every time a change is made to one of the items listed in the **Status** window. For input and output files, the complete path and filename are listed. However, the left portion of the file string is truncated if the path and filename exceed 32 characters.

Info

This main menu option provides on-screen information about the authorship and development of ACORn. Additional copies of the users guide and program diskettes, along with program support, may be obtained from the individuals listed on the information screen. Comments on the performance of the ACORn program are welcome. To clear the **Info** screen, press any key or the left mouse button.

Exit

To exit the ACORn program, highlight **Exit** and strike the ENTER key or the left mouse button.

INPUT DATA REQUIREMENTS

To run the complete program, ACORn requires two tree lists as data input: one for the advance reproduction and the other for the overstory before harvest. The overstory (stump sprouting) data are used to estimate contributions to future stocking from stump sprouts. Estimating the contribution of advance reproduction to future stocking requires the preharvest input file. Either or both files can be used. In addition, information on stand and site factors (site index, slope aspect, slope position, and overstory age) is required for both lists. The two lists must be in separate data input files. Recommendations for conducting a preharvest inventory of the overstory and advance reproduction, along with examples of plot tally sheets, are provided in Appendix 6.

Data input files for ACORn must be created in a text editor, spreadsheet, or word processor. Data files must be saved as ASCII text files with one or more blank spaces between data items (commas or tabs **cannot** be used to separate data elements). Appendices 2 and 3 show sample input files. Records with missing information or formatting errors will be ignored.

Advance Reproduction Data Variables

Advance reproduction data files must include three levels of information on stands, plots, and trees. These are listed and described below.

Stand Number

Plot Number

Species Code (USDA Forest Service numeric species codes are required, see Appendix 1.)

Plot Size (Plot size must be expressed in acres. Plots can be any size.)

> **Recommendation**: Inventory advance reproduction on circular 0.001-acre plots (3.72-foot radius). Within a stand, sample at least 30 well-distributed plots.

Slope Aspect Code

Slope aspect must be expressed by one of the following numeric codes:

1 = 180° to 270° azimuth (southwest-facing slopes);

2 = 0° to 90° azimuth (northeast-facing slopes); and

3 = all other azimuths (southeast- and northwest-facing slopes, level topography, and all slopes ≤10 percent).

Slope Position Code

Slope position must be expressed by one of the following numeric codes:

1 = upper one-third and flat, narrow ridge tops;

2 = middle one-third and level topography (≤10 percent slope); and

3 = lower one-third and bottoms.

Slope aspect and position must be specified at one of the data levels, i.e., the stand, plot, or tree level. When not specified at the plot or tree level, values default to the next higher level. For example, if slope aspect and position are not specified at the tree level but they are given at the plot level, then plot values are applied to all trees found on that plot. Similarly, if slope aspect and position are not specified at the plot level but are given at the stand level, then those values are applied to all plots within the stand and to all trees within the plots.

Individual Tree Measurements

Two measurements are required for each tree <1.6 inches d.b.h.:

(1) Basal stem diameter measured 1 inch above ground, and

(2) total live height.

Measurements must be in English (imperial) units. Basal diameters must be measured in inches and heights in feet. **Multiple-stemmed trees (sprout clumps) should be measured and recorded as a single tree.** Diameter and height of the largest stem should be recorded. Measure and record trees of all species occurring within a plot that are of interest and included in the species list in Appendix 1.

Recommendation: Measure diameters in tenths of inches (with a small caliper) and heights in tenths of feet.

Advance Reproduction Data Format

An advance reproduction data file must include at least 4 lines of data. It is not necessary to insert a blank line between the stand and the first plot data line, but additional plots must be separated by at least one blank line between the new plot line and the last tree data line in the previous plot. One valid input tree is required in the entire data file for ACORn to run. A valid input tree is one with a proper species code and a complete set of variables as described below. Records with errors are ignored.

Line 1: This is the header line. It must include the word ACORN. For example:

```
This is ACORN data file ADREP2.DAT
```

Line 2: This is the stand information line. It includes, in order: stand number, slope aspect code, and slope position code—each separated by a blank space. Slope aspect code and slope position code are optional if specified elsewhere. The first field must contain a numeric value. For example:

```
1 3 2
```

Line 3: This is a plot identification line. It includes, in order: plot number, plot size (acres), slope aspect code and slope position code—each separated by a blank space. Slope aspect code and slope position code are optional if specified elsewhere. The first two fields must contain a numeric value. For example:

```
12 .001 3 2
```

When not included, the default values for slope aspect code and slope position code are those specified on the stand (line 2) or tree data line (line 4).

Line 4 and beyond: Line 4 is a tree data line. It includes, in order: species code (Appendix 1), tree basal diameter (inches), tree height (feet), slope aspect code, and slope position code—each separated by a blank space. Slope aspect code and slope position code are optional if specified elsewhere. The first two fields must contain a numeric value. When not included, the default values for slope aspect code and slope position code are those specified on the stand (line 2) or plot data line (line 3). There is no practical limit to the number of tree data lines. An example of three tree data lines is shown below.

```
400 0.3 2.7 3 2
802 0.7 10.9 3 2
491 0.2 2.1 3 2
```

Successive plots must be separated by blank lines. Some plots may have no advance reproduction. When that occurs, enter a plot number and plot size on the plot line. It is not necessary to enter any tree data lines. For example:

```
13 .001 3 2
```

Not accounting for empty plots will result in overestimating future stand stocking. A sample input data file for advance reproduction is presented in Appendix 2.

> **Recommendation**: Create data files in a word processor or DOS text editor. Export them as ASCII files to the ACORN subdirectory.

Overstory Data Variables

Overstory data files must include the following information on stand, plot, and tree variables:

Stand Number

Stand Age

> **Recommendation**: Trees in inferior (suppressed and intermediate) crown classes may be younger than trees in the superior (dominant or co-dominant) crown classes. However, where trees in inferior classes are numerous, contributions to future stocking from stump sprouts may be seriously underestimated if stand age is based only on trees in dominant and co-dominant crown classes. Where trees in the inferior classes are numerous, determine their ages and enter those ages on the tree data lines as indicated below.

Stand Site Index for Black Oak

> **Recommendation**: For Missouri stands, use McQuilkin's (1974) site index tables.

Plot Number

Plot Size

Plot size must be given as a decimal proportion of an acre. Plots can be any size, and there is no practical upper limit on their number.

> **Recommendation**: Inventory the overstory on 0.05-acre plots (26.3-foot radius). Within a stand, sample trees on at least 10 well-distributed plots per stand.

Species Code (USDA Forest Service numeric species codes are required, see Appendix 1.)

Stand or tree age and site index must be specified at one of the data levels, i.e., the stand, plot, or tree level. When not specified at the plot or tree level, values default to the next higher level. For example, if age and site index are not specified at the tree level but they are given at the plot level, then plot values are applied to all trees found on that plot. Similarly, if age and site index are not specified at the plot level but are given at the stand level, then those values are applied to all plots within the stand and all trees within the plots.

Individual Tree Measurements

The d.b.h. of all living trees $\geq$1.6 inches is required. D.b.h. must be measured in inches. Optional measurements include tree age (years) and site index (feet). If tree age and site index are omitted, values default to those specified for the stand or the plot.

> **Recommendation**: Record tree diameters in 1-inch classes.

Overstory Data Format

An overstory data set must include at least 4 lines of data. It is not necessary to insert a blank line between the stand and the first plot data line, but additional plots must be separated by at least one blank line between the new plot line and the last tree data line in the previous plot. One valid input tree is required in the entire data file for ACORn to run. A valid input tree is one with a proper species code and a complete set of variables as described below. Records with errors are ignored.

Line 1: This is the header line. It must include the word ACORN. For example:

```
This is ACORN data file STUMP2.DAT
```

Line 2: This is the stand information line. It includes, in order: stand number, stand age, and stand site index—each separated by a blank space. Stand age and site index are optional if they are specified elsewhere. The first field must contain a numeric value. For example:

```
1 84 65
```

Line 3: This is a plot identification line. It includes, in order: plot number, plot size (acres), age of trees on the plot (years), and site index (feet)—each separated by a blank space. Age and site index are optional if they are specified elsewhere. The first two fields must contain a numeric value. For example:

```
1 .05 84 65
```

Line 4 and beyond: Line 4 is a tree data line. It includes, in order: a species code (Appendix 1), tree d.b.h. (inches), tree age, and site index—each separated by a blank space. Tree age and site index are optional if they are specified elsewhere. The first two fields must contain a numeric value. For example:

```
837 15.8 86 65
837 14.2 82 65
802 9.3 88 65
835 7.9 75 65
400 7.6 78 65
806 12.3 77 65
802 3.5 37 89 65
802 4.7 45 85 65
```

When the values for tree age and site index are not specified, they default to those given on the stand line (line 2) or the plot data line (line 3).

Successive plots must be separated by blank lines. There is no practical upper limit to the number of plot and data lines. Some plots may have no overstory trees. When that occurs, enter a plot number and plot size on the plot line. For example:

```
2 .05 84 65
```

Not accounting for empty plots will result in overestimating future stand stocking. A sample input overstory data file is presented in Appendix 3.

OUTPUT DATA DESCRIPTION

The **Brief** output option is default and produces the following tables when both overstory and advance reproduction data files are used:

(1) Number of **stump sprouts at stand age 5 for all species combined** by height classes,

(2) Number of trees originating from **advance reproduction and stump sprouts combined at stand age 10 for all species combined** by d.b.h. classes,

(3) Number of trees originating from **advance reproduction and stump sprouts combined at stand age 21 for all species combined** by d.b.h. classes,

(4) Stocking percent of both **advance reproduction and stump sprouts combined at stand age 21 for all species combined** by d.b.h. classes, and

(5) A summary of total number of trees and stocking value for the whole stand.

The **Complete** output option produces the following tables:

(1) Number of **stump sprouts at stand age 5 by species** and height classes,

(2) Number of **stump sprouts at stand age 10 by species** and d.b.h. classes,

(3) Number of trees originating from **advance reproduction at stand age 10 by species** and d.b.h. classes,

(4) Number of trees originating from **advance reproduction and stump sprouts combined at stand age 10 by species** and d.b.h. classes,

(5) Number of **stump sprouts at stand age 21 by species** and d.b.h. classes,

(6) Number of trees originating from **advance reproduction at stand age 21 by species** and d.b.h. classes,

(7) Number of trees originating from **advance reproduction and stump sprouts combined at stand age 21 by species** and d.b.h. classes,

(8) Percent stocking of **advance reproduction and stump sprouts combined at stand age 21 by species** and d.b.h. classes, and

(9) A summary of total number of trees and stocking value for the whole stand and for individual species.

All of the above tables list the number of trees per acre by user-specified or default d.b.h. and height classes.

After the ACORn program has run, obtain printed output by exiting the program and proceeding to the DOS prompt in the subdirectory where the output data files were stored. Output can be printed by typing PRINT followed by the file name and then striking the ENTER key.

GUIDELINES FOR ASSESSING ADEQUACY OF STOCKING

By the time stands reach 21 years, the *total* stand stocking (based on Gingrich, 1967) of trees 1-inch d.b.h. and larger is expected to be at or near 100 percent (i.e., average maximum density). This stocking level is usually attained regardless of the pre-harvest condition of the stand. Because the definition of average maximum density considers all living stems of all trees, ACORn tends to underestimate total stand stocking by 10 to 20 percent for the following reasons:

- With the exception of hickory, the model does not account for stump sprouts originating from overstory non-oaks. For example, flowering dogwood is a common and sometimes abundant member of the subcanopy that can produce dozens of stems within a single sprout clump. These sprout clumps may persist for 20 years or longer after overstory removal.

- The model may not account for all of the species present. ACORn does not account for contributions to stocking from shortleaf pine, eastern redcedar, maples, cherries, and other species that can occupy considerable growing space.

The stocking reported by ACORn therefore pertains to only those species (Appendix 1) and sources of reproduction that the model can account for. The model nevertheless can be used to assess the adequacy of stocking of "acceptable growing stock." Sander and others (1984) proposed that for a stand to be considered adequately stocked with oaks, codominant and dominant oaks should comprise at least 30 percent stocking by the time the stand is 20 years old (about 3 inches in mean diameter). At that age and on average sites, stands at 30 percent stocking can be expected to fully utilize growing space (i.e., attain at least B-level stocking as defined by Gingrich (1967)) within 10 years. We believe that this expectation may be somewhat conservative because many trees in the intermediate crown class, especially oaks, may over time move into superior crown classes. We suggest that the minimum acceptable level of stocking occurs when ACORn estimates that stocking equals or exceeds 30 percent for acceptable species in intermediate and larger crown classes at stand age 21.

LITERATURE CITED

Dey, Daniel C. 1991. **A comprehensive Ozark regenerator**. Columbia, MO: University of Missouri. 283 p. Ph.D. dissertation.

Dey, Daniel C.; Johnson, Paul S.; Garrett, H.E. 1996. **Modeling the regeneration of oak stands in the Missouri Ozark Highlands**. Canadian Journal of Forest Research. 26(4): 573-583.

Gingrich, Samuel F. 1967. **Measuring and evaluating stocking and stand density in upland hardwood forests in the Central States**. Forest Science. 13(1): 38-53.

McQuilkin, Robert A. 1974. **Site index prediction table for black, scarlet, and white oaks in southeastern Missouri**. Res. Pap. NC-108. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 8 p.

Sander, Ivan L.; Johnson, Paul S.; Rogers, Robert. 1984. **Evaluating oak advance reproduction in the Missouri Ozarks.** Res. Pap. NC-251. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 16 p.

APPENDIX 1. Species codes.[a]

Species	Codes
Bitternut hickory	402
Blackgum	694
Blackjack oak	824
Black oak	837
Chinkapin oak	826
Flowering dogwood	491
Hickory (all species)	400
Mockernut hickory	409
Northern red oak	833
Pignut hickory	403
Post oak	835
Sassafras	931
Scarlet oak	806
Shagbark hickory	407
Shellbark hickory	405
Southern red oak	812
White oak	802

[a] USDA Forest Service codes.

APPENDIX 2. Sample advance reproduction input data file.

```
This is ACORN advanced reproduction sample data file  ⇦
1 3 1                                                 ⇦
1 0.004 3 1                                           ⇦
931  0.116   1.0
931  0.116   1.0
931  0.254   2.0
931  0.254   2.0
931  0.944   7.0
837  0.265   1.0
837  0.265   1.0
837  0.593   3.0
491  1.244   8.0
400  0.715   4.0

2 0.004 3 1                                           ⇦
931  0.116   1.0
931  0.116   1.0
931  0.116   1.0
931  0.116   1.0
931  0.116   1.0
931  0.254   2.0
931  0.254   2.0
931  0.254   2.0
931  0.392   3.0
400  0.857   5.0
802  0.966   6.0

3 0.004 3 1                                           ⇦
694  0.129   1.0
694  0.267   2.0
694  0.681   5.0
694  1.233   9.0
694  1.233   9.0
694  0.129   1.0
931  0.254   2.0
931  0.254   2.0
802  0.815   5.0
837  0.265   1.0
837  0.265   1.0
837  0.593   3.0
491  0.047   1.0
491  0.902   6.0
491  1.415   9.0
806  0.231   1.0
```

Identifies the file as ACORn input data and must contain the word ACORN

Stand 1, slope aspect=3, slope position=1

Plot 1, 0.004 acre in size, slope aspect=3, slope position=1

Tree data lines for plot 1 showing species code, basal diameter and height for each stem of advanced reproduction

Plot 2, 0.004 acre in size, slope aspect=3, slope position=1

Tree data lines for plot 2 showing species code, basal diameter and height for each stem of advanced reproduction

Plot 3, 0.004 acre in size, slope aspect=3, slope position=1

Tree data lines for plot 3 showing species code, basal diameter and height for each stem of advanced reproduction

```
4 0.004 3 1
400  0.431   2.0
400  1.283   8.0
400  0.715   4.0
400  0.857   5.0
931  0.116   1.0
931  0.254   2.0
931  0.254   2.0
931  0.254   2.0
931  0.392   3.0
931  0.392   3.0
931  0.392   3.0
931  0.530   4.0
931  0.668   5.0
931  0.668   5.0
931  0.806   6.0
931  0.806   6.0
931  0.944   7.0
802  0.211   1.0
802  0.211   1.0
802  0.211   1.0
802  0.211   1.0
835  0.525   2.0
837  0.593   3.0
491  0.560   4.0
```

⇦ Plot 4, 0.004 acre in size, slope aspect=3, slope position=1

Tree data lines for plot 4 showing species code, basal diameter and height for each stem of advanced reproduction

```
5 0.004 3 1
802  0.513   3.0
802  0.664   4.0
802  1.268   8.0
802  1.419   9.0
802  1.419   9.0
802  0.211   1.0
931  0.116   1.0
931  0.116   1.0
931  0.116   1.0
931  0.116   1.0
931  0.116   1.0
931  0.116   1.0
931  0.254   2.0
931  0.254   2.0
931  0.116   1.0
931  0.254   2.0
931  0.254   2.0
931  0.254   2.0
931  0.254   2.0
400  0.431   2.0
400  0.715   4.0
```

⇦ Plot 5, 0.004 acre in size, slope aspect=3, slope position=1

Tree data lines for plot 5 showing species code, basal diameter and height for each stem of advanced reproduction

```
6 0.004 3 3
802  0.211   1.0
802  0.362   2.0
802  0.664   4.0
802  0.362   2.0
931  0.254   2.0
931  0.254   2.0
694  0.405   3.0
694  0.543   4.0
491  0.047   1.0
491  0.047   1.0
491  0.389   3.0
491  1.244   8.0
491  1.244   8.0
400  0.431   2.0
```

⇦ Plot 6, 0.004 acre in size, slope aspect=3, slope position=3

Tree data lines for plot 6 showing species code, basal diameter and height for each stem of advanced reproduction

```
7 0.004 3 3
491  0.218   2.0
931  0.116   1.0
931  0.116   1.0
931  0.254   2.0
931  0.254   2.0
931  0.254   2.0
931  0.254   2.0
931  0.254   2.0
931  0.254   2.0
931  0.392   3.0
931  0.392   3.0
931  0.530   4.0
931  0.668   5.0
931  0.668   5.0
931  0.806   6.0
931  0.806   6.0
931  0.944   7.0
931  1.220   9.0
491  1.415   9.0
802  0.211   1.0
400  0.573   3.0
491  0.218   2.0
835  0.525   2.0
```

⇦ Plot 7, 0.004 acre in size, slope aspect=3, slope position=3

Tree data lines for plot 7 showing species code, basal diameter and height for each stem of advanced reproduction

```
8 0.004 3 3
400  0.715   4.0
931  0.116   1.0
931  0.668   5.0
931  0.944   7.0
931  0.944   7.0
931  1.082   8.0
931  1.220   9.0
931  1.220   9.0
835  0.525   2.0
802  0.211   1.0
802  0.362   2.0
802  0.362   2.0
802  0.362   2.0
802  1.419   9.0
491  0.560   4.0
491  0.218   2.0
491  0.218   2.0
491  0.560   4.0

9 0.004 3 3
931  0.392   3.0
491  0.047   1.0
400  0.289   1.0
491  1.415   9.0
931  0.116   1.0
491  1.244   8.0
491  1.073   7.0
694  0.681   5.0
491  0.047   1.0
400  0.289   1.0
400  0.573   3.0
931  0.116   1.0
931  0.116   1.0
931  0.116   1.0
931  0.254   2.0
931  0.392   3.0
931  0.116   1.0
694  0.405   3.0
931  0.116   1.0
400  0.431   2.0
931  0.116   1.0
802  1.419   9.0
802  1.419   9.0
491  1.244   8.0
491  1.244   8.0
491  0.902   6.0
931  0.116   1.0
```

⇦ Plot 8, 0.004 acre in size, slope aspect=3, slope position=3

Tree data lines for plot 8 showing species code, basal diameter and height for each stem of advanced reproduction

⇦ Plot 9, 0.004 acre in size, slope aspect=3, slope position=3

Tree data lines for plot 9 showing species code, basal diameter and height for each stem of advanced reproduction

```
10 0.004 3 3
694  0.819   6.0
931  0.668   5.0
806  0.231   1.0
931  0.116   1.0
931  0.392   3.0
837  0.265   1.0
931  0.392   3.0
931  0.116   1.0
931  0.116   1.0
837  0.265   1.0
837  0.265   1.0
837  0.265   1.0
837  0.265   1.0
837  0.265   1.0
931  0.116   1.0
931  0.254   2.0
931  0.116   1.0
694  1.233   9.0
837  0.265   1.0
837  0.593   3.0
837  0.593   3.0
694  0.543   4.0
837  0.265   1.0
931  0.116   1.0
931  0.668   5.0
931  0.116   1.0
802  0.966   6.0
802  0.211   1.0
802  0.211   1.0
931  0.254   2.0
931  0.254   2.0
931  0.116   1.0
837  0.265   1.0
400  0.715   4.0
694  1.233   9.0
```

⇦ Plot 10, 0.004 acre in size, slope aspect=3, slope position=3

Tree data lines for plot 10 showing species code, basal diameter and height for each stem of advanced reproduction

APPENDIX 3. Sample overstory data file.

This is ACORN stump sprouting sample data file ⇦

Identifies the file as ACORn input data and must contain the word ACORN

1 70 63 ⇦

Stand 1, age=70, site index=63

1 0.05 ⇦

Plot 1, 0.05 acre in size

835 8.7
837 9.8
835 11.8
835 9.7
835 9.8
837 15.0
835 6.6
837 12.0
802 11.6
400 7.7
802 15.7

Tree data lines for plot 1 showing species code and dbh for each overstory stem

2 0.05 ⇦

Plot 2, 0.05 acre in size

837 8.8
837 10.0
837 13.8
837 9.0
837 10.8
835 9.7
837 10.0
837 12.0
802 10.8
400 9.0
802 13.1
806 12.8

Tree data lines for plot 2 showing species code and dbh for each overstory stem

3 0.05 ⇦

Plot 3, 0.05 acre in size

400 5.5
837 11.5
802 14.4
802 9.8
835 9.7
837 14.4
837 14.4
837 10.0
802 15.6
400 5.5
806 13.4

Tree data lines for plot 3 showing species code and dbh for each overstory stem

4 0.05 ⇦ Plot 4, 0.05 acre in size
837 14.6
837 11.6
837 14.2
835 9.6
802 8.8
400 6.6
837 9.9
837 10.4
835 13.7
400 12.1
802 14.5
806 12.9

Tree data lines for plot 4 showing species code and dbh for each overstory stem

5 0.05 ⇦ Plot 5, 0.05 acre in size
835 14.6
835 8.7
835 9.8
400 6.6
835 9.6
835 10.7
802 12.6
835 8.6
837 12.8
837 15.7
802 14.2
802 13.7

Tree data lines for plot 5 showing species code and dbh for each overstory stem

6 0.05 ⇦ Plot 6, 0.05 acre in size
835 9.6
835 8.5
835 9.7
835 11.6
835 13.7
400 3.4
806 10.2
806 13.4
835 9.7
802 12.7
837 15.9
837 12.9

Tree data lines for plot 6 showing species code and dbh for each overstory stem

```
7 0.05          ⇦
835 9.6
802 11.8
835 12.5
835 14.6
835 10.5
806 12.4
824 8.0
802 13.8
824 9.1
400 9.8
837 14.9
837 13.9

8 0.05          ⇦
400 4.6
837 11.9
802 12.9
806 13.5
837 8.4
837 12.2
835 9.9
806 13.3
400 7.7
802 16.2

9 0.05          ⇦
835 9.8
824 8.0
824 9.1
835 11.9
806 15.6
806 12.4
806 13.4
400 6.6
837 14.9
837 15.9

10 0.05         ⇦
835 9.6
806 11.3
806 14.5
835 12.6
835 8.7
400 5.5
802 8.8
806 10.6
837 14.9
837 13.6
```

Plot 7, 0.05 acre in size

Tree data lines for plot 7 showing species code and dbh for each overstory stem

Plot 8, 0.05 acre in size

Tree data lines for plot 8 showing species code and dbh for each overstory stem

Plot 9, 0.05 acre in size

Tree data lines for plot 9 showing species code and dbh for each overstory stem

Plot 10, 0.05 acre in size

Tree data lines for plot 10 showing species code and dbh for each overstory stem

APPENDIX 4. Example of a **Brief** output data file.

Output file generated by ACORn program, v.2.0

Date: August 2, 1996
Time: 22:37:12

Model run parameters

Stump sprouting input file:	STUMP1.TXT
Advanced reproduction input file:	ADREP1.TXT
Output type:	brief
Height size class (ft) :	1.0000
DBH size class (in) :	1.0000

Height distribution at stand age 5. Stump sprouting (tree/ac)

CLASS MIDPOINT TREE	0.5	1.5	2.5	3.5	4.5	5.5
WHOLE STAND	0.02	0.11	0.29	0.67	1.35	2.43
CLASS MIDPOINT TREE	6.5	7.5	8.5	9.5	10.5	11.5
WHOLE STAND	3.90	5.51	6.90	7.56	7.64	6.93
CLASS MIDPOINT TREE	12.5	13.5	14.5	15.5	16.5	17.5
WHOLE STAND	5.87	4.72	3.77	3.01	2.35	1.78
CLASS MIDPOINT TREE	18.5	19.5	20.5	21.5	22.5	23.5
WHOLE STAND	1.29	0.88	0.57	0.35	0.19	0.10
CLASS MIDPOINT TREE	24.5					
WHOLE STAND	0.06					

DBH distribution at stand age 10. Whole stand (tree/ac)

CLASS MIDPOINT TREE	0.5	1.5	2.5	3.5	4.5	5.5
WHOLE STAND	2173.22	1032.14	170.50	65.09	10.72	0.13
CLASS MIDPOINT TREE	6.5	7.5	8.5	9.5		
WHOLE STAND	0.00	0.00	0.00	0.00		

DBH distribution at stand age 21. Whole stand (tree/ac)

CLASS MIDPOINT TREE	0.5	1.5	2.5	3.5	4.5	5.5
WHOLE STAND	463.16	422.31	523.95	184.94	93.38	56.41
CLASS MIDPOINT TREE	6.5	7.5	8.5	9.5		
WHOLE STAND	11.90	6.37	1.25	0.09		

Stocking value distribution at stand age 21. Whole stand (%)

CLASS MIDPOINT TREE	0.5	1.5	2.5	3.5	4.5	5.5
WHOLE STAND	1.95	11.63	29.97	17.24	12.66	10.39
CLASS MIDPOINT TREE	6.5	7.5	8.5	9.5		
WHOLE STAND	2.85	1.91	0.46	0.04		

Stand summary at age 21. Whole stand

	Tree/acre	Stocking value (%)
WHOLE STAND	1763.77	89.09

APPENDIX 5. Example of a **Complete** output data file.

Output file generated by ACORn program, v.2.0

Date: August 2, 1996
Time: 22:52:40

Model run parameters

Stump sprouting input file:	STUMP1.TXT
Advanced reproduction input file:	ADREP1.TXT
Output type:	complete.
Height size class (ft) :	1.0000
DBH size class (in) :	1.0000

Height distribution at stand age 5. Stump sprouting (tree/ac)

CLASS MIDPOINT TREE	0.5	1.5	2.5	3.5	4.5	5.5
WHOLE STAND	0.02	0.11	0.29	0.67	1.35	2.43
DOGWOOD	0.00	0.00	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00	0.00	0.00
HICKORY	0.00	0.05	0.16	0.38	0.77	1.38
BLACKGUM	0.00	0.00	0.00	0.00	0.00	0.00
WHITE OAK	0.00	0.00	0.00	0.00	0.00	0.00
POST OAK	0.00	0.00	0.02	0.07	0.19	0.42
BLACKJACK OAK	0.00	0.01	0.02	0.05	0.09	0.16
BLACK OAK	0.02	0.05	0.10	0.16	0.27	0.40
SCARLET OAK	0.00	0.00	0.00	0.01	0.03	0.06

CLASS MIDPOINT TREE	6.5	7.5	8.5	9.5	10.5	11.5
WHOLE STAND	3.90	5.51	6.90	7.56	7.64	6.93
DOGWOOD	0.00	0.00	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00	0.00	0.00
HICKORY	2.17	2.95	3.52	3.57	3.35	2.67
BLACKGUM	0.00	0.00	0.00	0.00	0.00	0.00
WHITE OAK	0.01	0.02	0.04	0.09	0.15	0.22
POST OAK	0.78	1.23	1.62	1.81	1.71	1.37
BLACKJACK OAK	0.24	0.33	0.37	0.37	0.34	0.26
BLACK OAK	0.59	0.78	1.02	1.22	1.39	1.50
SCARLET OAK	0.12	0.20	0.33	0.50	0.71	0.92

CLASS MIDPOINT TREE	12.5	13.5	14.5	15.5	16.5	17.5
WHOLE STAND	5.87	4.72	3.77	3.01	2.35	1.78
DOGWOOD	0.00	0.00	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00	0.00	0.00
HICKORY	1.90	1.11	0.59	0.27	0.11	0.02
BLACKGUM	0.00	0.00	0.00	0.00	0.00	0.00
WHITE OAK	0.27	0.30	0.29	0.25	0.18	0.11
POST OAK	0.91	0.51	0.24	0.09	0.03	0.00
BLACKJACK OAK	0.18	0.10	0.05	0.02	0.01	0.00
BLACK OAK	1.51	1.45	1.32	1.14	0.90	0.69
SCARLET OAK	1.10	1.25	1.28	1.24	1.13	0.95

CLASS MIDPOINT TREE	18.5	19.5	20.5	21.5	22.5	23.5
WHOLE STAND	1.29	0.88	0.57	0.35	0.19	0.10
DOGWOOD	0.00	0.00	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00	0.00	0.00
HICKORY	0.00	0.00	0.00	0.00	0.00	0.00
BLACKGUM	0.00	0.00	0.00	0.00	0.00	0.00
WHITE OAK	0.06	0.03	0.01	0.00	0.00	0.00
POST OAK	0.00	0.00	0.00	0.00	0.00	0.00
BLACKJACK OAK	0.00	0.00	0.00	0.00	0.00	0.00
BLACK OAK	0.48	0.33	0.20	0.12	0.07	0.03
SCARLET OAK	0.74	0.53	0.35	0.22	0.13	0.07

CLASS MIDPOINT TREE	24.5
WHOLE STAND	0.06
DOGWOOD	0.00
SASSAFRAS	0.00
HICKORY	0.00
BLACKGUM	0.00
WHITE OAK	0.00
POST OAK	0.00
BLACKJACK OAK	0.00
BLACK OAK	0.02
SCARLET OAK	0.04

DBH distribution at stand age 10. Stump sprouting (tree/ac)

CLASS MIDPOINT TREE	0.5	1.5	2.5	3.5	4.5	5.5
WHOLE STAND	3.41	40.24	90.32	64.13	10.72	0.13
DOGWOOD	0.00	0.00	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00	0.00	0.00
HICKORY	2.06	15.26	6.65	0.10	0.00	0.00
BLACKGUM	0.00	0.00	0.00	0.00	0.00	0.00
WHITE OAK	0.30	4.97	15.52	11.08	1.73	0.01
POST OAK	0.35	7.18	25.71	20.90	3.70	0.06
BLACKJACK OAK	0.03	0.82	3.23	2.84	0.54	0.01
BLACK OAK	0.46	8.25	27.18	20.46	3.38	0.04
SCARLET OAK	0.21	3.76	12.03	8.75	1.38	0.01

CLASS MIDPOINT TREE	6.5	7.5	8.5	9.5
WHOLE STAND	0.00	0.00	0.00	0.00
DOGWOOD	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00
HICKORY	0.00	0.00	0.00	0.00
BLACKGUM	0.00	0.00	0.00	0.00
WHITE OAK	0.00	0.00	0.00	0.00
POST OAK	0.00	0.00	0.00	0.00
BLACKJACK OAK	0.00	0.00	0.00	0.00
BLACK OAK	0.00	0.00	0.00	0.00
SCARLET OAK	0.00	0.00	0.00	0.00

DBH distribution at stand age 10. Advanced reproduction (tree/ac)

CLASS MIDPOINT TREE	0.5	1.5	2.5	3.5	4.5	5.5
WHOLE STAND	2169.80	991.90	80.18	0.96	0.00	0.00
DOGWOOD	238.97	224.39	11.64	0.00	0.00	0.00
SASSAFRAS	868.02	170.45	0.39	0.00	0.00	0.00
HICKORY	280.25	91.67	0.09	0.00	0.00	0.00
BLACKGUM	219.62	68.05	0.00	0.00	0.00	0.00
WHITE OAK	263.81	253.05	61.51	0.96	0.00	0.00
POST OAK	30.89	33.65	1.38	0.00	0.00	0.00
BLACKJACK OAK	0.00	0.00	0.00	0.00	0.00	0.00
BLACK OAK	237.16	140.55	5.14	0.00	0.00	0.00
SCARLET OAK	31.08	10.10	0.04	0.00	0.00	0.00

CLASS MIDPOINT TREE	6.5	7.5	8.5	9.5
WHOLE STAND	0.00	0.00	0.00	0.00
DOGWOOD	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00
HICKORY	0.00	0.00	0.00	0.00
BLACKGUM	0.00	0.00	0.00	0.00
WHITE OAK	0.00	0.00	0.00	0.00

POST OAK	0.00	0.00	0.00	0.00
BLACKJACK OAK	0.00	0.00	0.00	0.00
BLACK OAK	0.00	0.00	0.00	0.00
SCARLET OAK	0.00	0.00	0.00	0.00

DBH distribution at stand age 10. Whole stand (tree/ac)

CLASS MIDPOINT TREE	0.5	1.5	2.5	3.5	4.5	5.5
WHOLE STAND	2173.22	1032.14	170.50	65.09	10.72	0.13
DOGWOOD	238.97	224.39	11.64	0.00	0.00	0.00
SASSAFRAS	868.02	170.45	0.39	0.00	0.00	0.00
HICKORY	282.31	106.93	6.73	0.10	0.00	0.00
BLACKGUM	219.62	68.05	0.00	0.00	0.00	0.00
WHITE OAK	264.11	258.02	77.03	12.03	1.73	0.01
POST OAK	31.24	40.83	27.09	20.90	3.70	0.06
BLACKJACK OAK	0.03	0.82	3.23	2.84	0.54	0.01
BLACK OAK	237.62	148.80	32.32	20.46	3.38	0.04
SCARLET OAK	31.30	13.85	12.07	8.75	1.38	0.01

CLASS MIDPOINT TREE	6.5	7.5	8.5	9.5
WHOLE STAND	0.00	0.00	0.00	0.00
DOGWOOD	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00
HICKORY	0.00	0.00	0.00	0.00
BLACKGUM	0.00	0.00	0.00	0.00
WHITE OAK	0.00	0.00	0.00	0.00
POST OAK	0.00	0.00	0.00	0.00
BLACKJACK OAK	0.00	0.00	0.00	0.00
BLACK OAK	0.00	0.00	0.00	0.00
SCARLET OAK	0.00	0.00	0.00	0.00

DBH distribution at stand age 21. Stump sprouting (tree/ac)

CLASS MIDPOINT TREE	0.5	1.5	2.5	3.5	4.5	5.5
WHOLE STAND	4.63	7.99	6.89	5.89	5.54	4.57
DOGWOOD	0.00	0.00	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00	0.00	0.00
HICKORY	4.28	6.51	3.55	1.04	0.20	0.02
BLACKGUM	0.00	0.00	0.00	0.00	0.00	0.00
WHITE OAK	0.02	0.15	0.44	0.63	0.43	0.14
POST OAK	0.27	0.94	1.49	1.07	0.34	0.04
BLACKJACK OAK	0.02	0.11	0.30	0.42	0.31	0.11
BLACK OAK	0.03	0.18	0.61	1.32	1.85	1.76
SCARLET OAK	0.01	0.10	0.49	1.40	2.41	2.50

CLASS MIDPOINT TREE	6.5	7.5	8.5	9.5
WHOLE STAND	2.79	1.18	0.34	0.08
DOGWOOD	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00
HICKORY	0.00	0.00	0.00	0.00
BLACKGUM	0.00	0.00	0.00	0.00
WHITE OAK	0.02	0.00	0.00	0.00
POST OAK	0.00	0.00	0.00	0.00
BLACKJACK OAK	0.02	0.00	0.00	0.00
BLACK OAK	1.16	0.56	0.20	0.06
SCARLET OAK	1.59	0.62	0.14	0.02

DBH distribution at stand age 21. Advanced reproduction (tree/ac)

CLASS MIDPOINT TREE	0.5	1.5	2.5	3.5	4.5	5.5
WHOLE STAND	458.53	414.32	517.06	179.06	87.84	51.83
DOGWOOD	56.38	96.96	125.73	79.59	11.37	0.08
SASSAFRAS	0.00	10.19	124.79	0.00	0.00	0.00
HICKORY	185.72	79.76	0.65	6.48	0.09	0.00
BLACKGUM	37.99	92.90	54.13	6.93	0.00	0.00
WHITE OAK	107.75	73.08	126.39	54.02	51.59	46.66
POST OAK	14.15	7.12	20.84	8.17	0.84	1.30
BLACKJACK OAK	0.00	0.00	0.00	0.00	0.00	0.00
BLACK OAK	51.09	47.30	60.04	21.55	22.81	3.70
SCARLET OAK	5.45	7.00	4.50	2.32	1.15	0.10

CLASS MIDPOINT TREE	6.5	7.5	8.5	9.5
WHOLE STAND	9.11	5.18	0.91	0.01
DOGWOOD	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00
HICKORY	0.00	0.00	0.00	0.00
BLACKGUM	0.00	0.00	0.00	0.00
WHITE OAK	7.52	5.04	0.90	0.01
POST OAK	0.02	0.00	0.00	0.00
BLACKJACK OAK	0.00	0.00	0.00	0.00
BLACK OAK	1.56	0.14	0.01	0.00
SCARLET OAK	0.02	0.00	0.00	0.00

DBH distribution at stand age 21. Whole stand (tree/ac)

CLASS MIDPOINT TREE	0.5	1.5	2.5	3.5	4.5	5.5
WHOLE STAND	463.16	422.31	523.95	184.94	93.38	56.41
DOGWOOD	56.38	96.96	125.73	79.59	11.37	0.08
SASSAFRAS	0.00	10.19	124.79	0.00	0.00	0.00
HICKORY	190.00	86.28	4.20	7.52	0.29	0.02
BLACKGUM	37.99	92.90	54.13	6.93	0.00	0.00
WHITE OAK	107.77	73.23	126.84	54.65	52.03	46.80
POST OAK	14.42	8.07	22.33	9.24	1.18	1.35
BLACKJACK OAK	0.02	0.11	0.30	0.42	0.31	0.11
BLACK OAK	51.12	47.48	60.65	22.88	24.66	5.46
SCARLET OAK	5.46	7.10	4.99	3.73	3.55	2.59

CLASS MIDPOINT TREE	6.5	7.5	8.5	9.5
WHOLE STAND	11.90	6.37	1.25	0.09
DOGWOOD	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00
HICKORY	0.00	0.00	0.00	0.00
BLACKGUM	0.00	0.00	0.00	0.00
WHITE OAK	7.54	5.05	0.90	0.01
POST OAK	0.02	0.00	0.00	0.00
BLACKJACK OAK	0.02	0.00	0.00	0.00
BLACK OAK	2.72	0.70	0.21	0.06
SCARLET OAK	1.61	0.62	0.14	0.02

Stocking value distribution at stand age 21. Whole stand (%)

CLASS MIDPOINT TREE	0.5	1.5	2.5	3.5	4.5	5.5
WHOLE STAND	1.95	11.63	29.97	17.24	12.66	10.39
DOGWOOD	0.24	2.67	7.19	7.42	1.54	0.01
SASSAFRAS	0.00	0.28	7.14	0.00	0.00	0.00
HICKORY	0.80	2.38	0.24	0.70	0.04	0.00
BLACKGUM	0.16	2.56	3.10	0.65	0.00	0.00
WHITE OAK	0.45	2.02	7.25	5.09	7.05	8.62
POST OAK	0.06	0.22	1.28	0.86	0.16	0.25
BLACKJACK OAK	0.00	0.00	0.02	0.04	0.04	0.02
BLACK OAK	0.22	1.31	3.47	2.13	3.34	1.01
SCARLET OAK	0.02	0.20	0.29	0.35	0.48	0.48

CLASS MIDPOINT TREE	6.5	7.5	8.5	9.5
WHOLE STAND	2.85	1.91	0.46	0.04
DOGWOOD	0.00	0.00	0.00	0.00
SASSAFRAS	0.00	0.00	0.00	0.00
HICKORY	0.00	0.00	0.00	0.00
BLACKGUM	0.00	0.00	0.00	0.00
WHITE OAK	1.80	1.52	0.33	0.01
POST OAK	0.00	0.00	0.00	0.00
BLACKJACK OAK	0.00	0.00	0.00	0.00
BLACK OAK	0.65	0.21	0.08	0.03
SCARLET OAK	0.38	0.19	0.05	0.01

Stand summary at age 21. Whole stand

	Tree/acre	Stocking value (%)
WHOLE STAND	1763.77	89.09
DOGWOOD	370.11	19.07
SASSAFRAS	134.97	7.42
HICKORY	288.30	4.16
BLACKGUM	191.94	6.46
WHITE OAK	474.81	34.15
POST OAK	56.59	2.83
BLACKJACK OAK	1.29	0.13
BLACK OAK	215.93	12.44
SCARLET OAK	29.82	2.44

APPENDIX 6. Preharvest inventory instructions and data sheets.

A typical application of ACORn arises when a forester needs to estimate the size and stocking of oak and other species expected to regenerate after overstory removal in an Ozark oak-hickory forest (e.g., after a clearcut or shelterwood final removal). Before treatment, information must be collected on the number, size, and species of overstory trees and advance reproduction. Although there are many possible ways to collect appropriate data for application in ACORn, fixed-size inventory plots located on a systematic grid or along random transect lines usually work well.

Typically, overstory sample plots are circular and between 0.05 and 0.2 acres in size. Advance reproduction plots are smaller, typically about 0.001 acre. The number of plots measured should be sufficient to characterize the conditions of the site. Highly variable sites require more sample plots than sites where the overstory and advance reproduction are relatively uniform. Sample the overstory on at least 10 plots and the advance reproduction on at least 30 plots. Sample sizes that include 100 observations in each file would be adequate in most situations, but generally, the more plots the better. The numbers of overstory plots and advance reproduction plots need not be equal. Sample field data sheets are shown on the following pages.

Advance Reproduction Data Form

	Stand ID	Date		Sheet ___ of ____
	Plot size (ac)	Slope aspect code		Slope position code

Note: Include all sampled plots even if they have no advance reproduction

Plot (xx)	Species Code (xxx)	Basal diameter to nearest 0.1" (xx.x)	Height to nearest 0.1' (xx.x)	Slope aspect code for plot *(optional)*	Slope postion code for plot *(optional)*

Radii for common plot sizes

Radius (ft)	*Plot size (ac)*	*Plots /ac*
3.7	0.001	1000
8.3	0.01	200
11.8	0.01	100
26.3	0.05	20
37.2	0.1	10
52.7	0.2	5
58.9	0.25	4
83.3	0.5	2

Slope Aspect Codes

1= Azimuth 180 to 270 deg.
2= Azimuth 0 to 90 deg.
3=All others

Slope Position Codes

1= upper one-third and flat, narrow ridgetops
2= middle one-third or less than 10% slope
3= lower one-third and bottoms

Species codes

402 Bitternut hickory
694 Blackgum
824 Blackjack oak
837 Black oak
826 Chinkapin oak
491 Flowering dogwood
400 Hickory (all spp)
409 Mockernut hickory
833 Northern red oak
403 Pignut hickory
835 Post oak
931 Sassafras
806 Scarlet oak
407 Shagbark hickory
405 Shellbark hickory
812 Southern red oak
802 White oak

Stump Sprout Data Form

	Stand ID		Date		Sheet ___ of ____		
	Plot size (ac)		Stand age (yr)		Site index (ft, age 50)		
Plot (xx)	Species Code (xxx)	Dbh to to nearest 1" (xx)	Tree or Plot Age (yr) *(optional)*	Tree or Plot site index (ft) *(optional)*	*Radii for common plot sizes*		
					Radius (ft)	*Plot size (ac)*	*Plots /ac*
					3.7	0.001	1000
					8.3	0.01	200
					11.8	0.01	100
					26.3	0.05	20
					37.2	0.1	10
					52.7	0.2	5
					58.9	0.25	4
					83.3	0.5	2

Species codes

402 Bitternut hickory
694 Blackgum
824 Blackjack oak
837 Black oak
826 Chinkapin oak
491 Flowering dogwood
400 Hickory (all spp)
409 Mockernut hickory
833 Northern red oak
403 Pignut hickory
835 Post oak
931 Sassafras
806 Scarlet oak
407 Shagbark hickory
405 Shellbark hickory
812 Southern red oak
802 White oak

Field Notes:

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Dey, Daniel C.; Ter-Mikaelian, Michael; Johnson, Paul S.; Shifley, Stephen R.

1996. **Users guide to ACORn: a comprehensive Ozark regeneration simulator**. Gen. Tech. Rep. NC-180. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 35 p.

Describes how to use the ACORn computer program for predicting number of trees per acre and stocking percent by species and diameter classes 21 years after complete overstory removal of oak stands in the Ozark Highlands of Missouri and adjacent States.

KEY WORDS: Oak, silviculture, model