

User's Guide to ACORn:
A Comprehensive Ozark Regeneration Simulator

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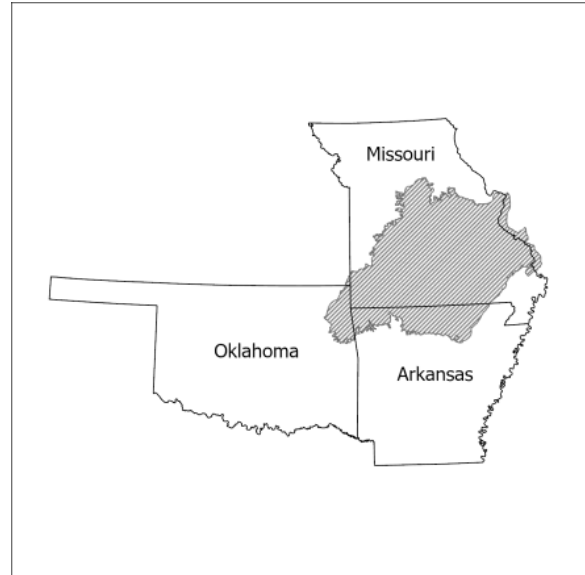
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Introduction

Welcome to ACORn version 3.0, a computer program to help forest managers predict the number and the species of trees that will regenerate following harvest in upland oak stands in the Ozark Highlands of Missouri and adjacent states. ACORn predicts the development of most important hardwood species including flowering dogwood, sassafras, blackgum, oaks and hickories. ACORn predicts the expected height or diameter distributions of major tree species at 5, 10 and 21 years after complete overstory removal. It also predicts basal area and stocking values by species and diameter class at ages 10 and 21. In addition preharvest stem density, basal area and stocking values by species and diameter classes are provided as a point of reference for evaluation of predictions. ACORn requires an inventory of advanced reproduction (trees < 1.6 inches d.b.h. and overstory (trees $\geq$ 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 completed;
- can be applied to clearcutting, shelterwood and group selection methods;
- 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;



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

- Should not be applied to stands where the tree species other than those listed in the Appendix are important members of the overstory or advanced reproduction or where they are expected to become important after harvest;
 - do not estimate the contribution of final harvest; 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.
-



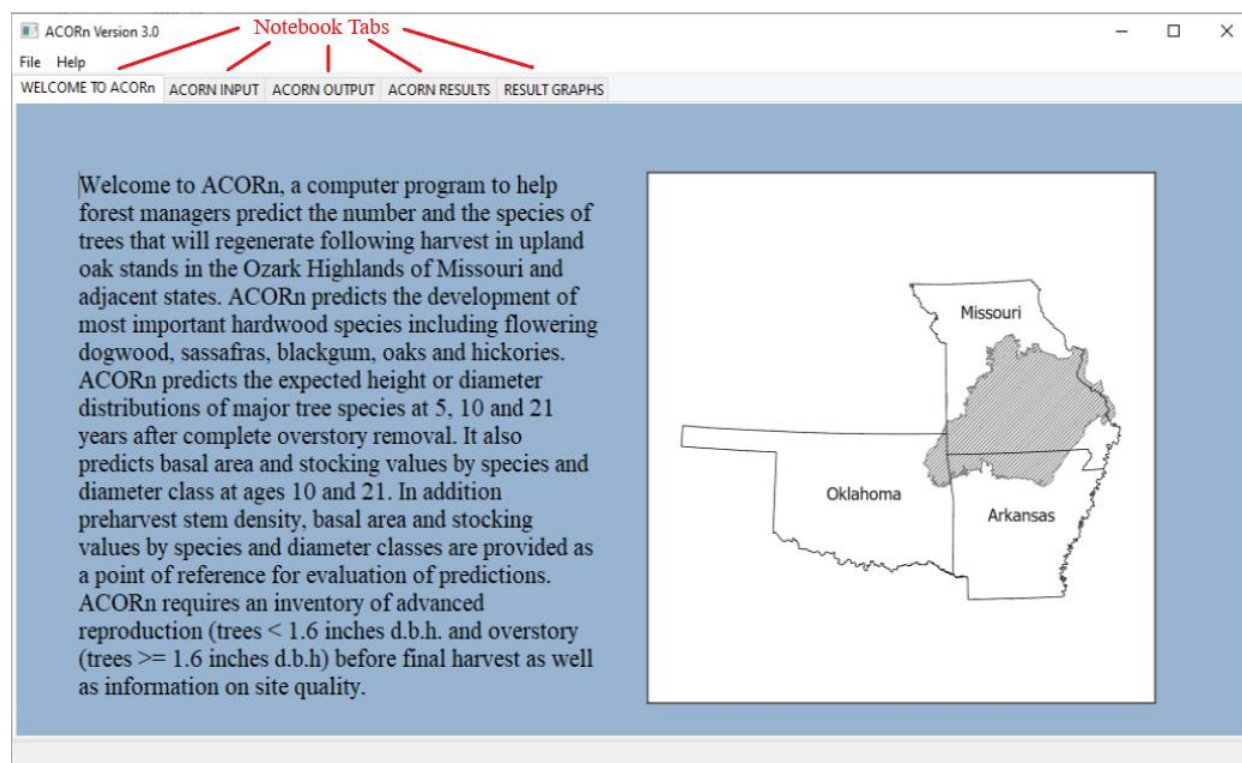
PROGRAM REQUIREMENTS

ACORn is currently compiled 32 bit for Windows 7, 8 and 10. It utilizes very little computer resources beyond that of the operating system. User generated data inputs must be created in another software such as a text editor or spreadsheet spread sheet program. The input data files need to be saved a text (.txt) file for use in ACORn. Sample data is included with the software to allow the user to familiarize themselves with the software. See Appendix for sample plot data collection sheets.

RUNNING THE PROGRAM

The ACORn interface is set up as a multi tab notebook. The user progresses through the tabs

from left to right, first selecting ACORN INPUT tab to select input files. Next select the output file options on the ACORN OUTPUT tab and the pressing the RUN button. After 2-3 seconds the RUN button label will change from RUN to DONE. After the button has changed to DONE, the user can click on the ACORN RESULTS tab of the notebook and view the output tables you selected. SELECTING OUTPUT TABLES IS NOT NECESSARY TO VIEW GRAPHS OF THE OUTPUT TABLES. You can simply select no output options and click the RUN/DONE button then immediately view all graphs produced by ACORn on the RESULT GRAPHS tab.



ACORn INPUT

Two buttons reside on the ACORn INPUT tab. The top button is used to load the tree inventory

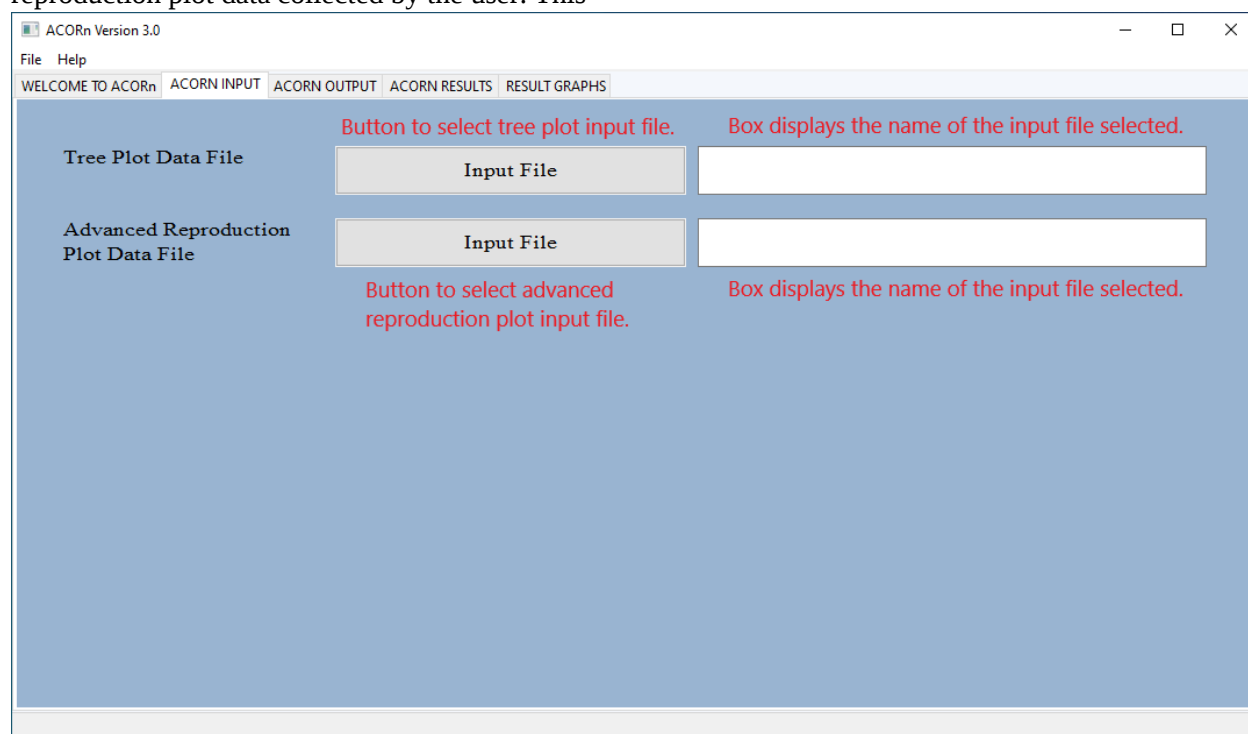


plot data collected by the user. This data is used to estimate the contributions of stump sprouts to the future stand. Instruction on how to collect

this data and sample data sheets for data collection appear in Appendix x. A sample data file named “Overstory_Plot_Data.txt” is included with the software.

The lower button is used to load the advanced reproduction plot data collected by the user. This

data is used to estimate the contributions of advanced reproduction to future stands. A sample data file named “Advanced_Reproduction_Plot_Data.txt” is included with the software.



ACORn OUTPUT

Below is the ACORn OUTPUT tab. On this tab you have all the controls to create 4 output table files. The top row of controls highlighted in red allows the user to create an output table with information based on the original overstory plot inventory file. This is helpful to evaluate the suitability of the software for estimating future stand composition for example if a stand contains too much maple, conifer or other non-modeled species, this software would be unsuitable to estimate future composition. Since the output tables generated for preharvest are for the existing stand no checkboxes occur under the STUMP SPROUT, ADVANCED REPRODUCTION OR COMBINED column headings. As on the ACORn INPUT tab there are buttons and boxes to select a new or existing output file for creation of the 4 different output

table files; PREHARVEST, YEAR 5, YEAR 10 and YEAR 21. File names are left to the decision of the user to connote its contents. The remaining red highlighted boxes fall under headings describing their function.

The HEIGHT checkbox falls under the STUMP SPROUT heading and on the YEAR 5 row, so by checking this box, a table of height distribution of stump sprouts at year 5 will be created. On the same year 5 row the red highlighted box gives the user a choice of how species are summarized for that table. MAJ is currently selected which means that the year 5 stump sprout height distribution will be summarized for MAJOR SPECIES. Under this selection, oak species not considered a major oak species are placed in a group called OTHER OAKS. The next choice which is not selected, SPP would have summarized the table for only



species that occurred in the stand but each species including non-major species are listed individually. The last choice OAK groups everything into 6 broad groups.

Moving down to the YEAR 10 row of controls in the red highlighted box shows STM selected. This means that the metric being reported is STEM DENSITY. The other 2 choices are BASAL AREA and PERCENT STOCKING.

Moving down to the bottom red highlighted box is a choice for the format of the output files. For visualization and printing of the table select the TEXT choice. Choose CSV to create an output

file in comma separated value (.CSV) format. On the windows operating system, if you have excel installed and double click on a .csv file it will automatically open in Excel.

Next to the bottom red highlighted box is the RUN / DONE button. Once you have all your output file configurations set, click the RUN / DONE button and the input data will be processed and the output files will be created at which point the label on the button will read DONE and it is safe to click the ACORN RESULTS tab to view the tables and look at graphs on the RESULT GRAPHS tab.

[illegible]

ACORn RESULTS

The ACORn RESULTS tab (below) allows you to view and print the output tables you just created you can view each output file by clicking the YEAR 5 REPORT, YEAR 10 REPORT, YEAR 21 REPORT or the PREHARVEST buttons. Only the tables that were specified on the previous tab will be

available to view and print. To get started printing navigate to the desired tables to print and make sure the printer font size box has an integer value between 8 and 14. We recommend a value of 10 to get the entire table on a single page. Press the large PRINT button on the upper left corner of the tab at which time a page setup window will appear.



ACORn Version 3.0

File Help

WELCOME TO ACORn ACORN INPUT ACORN OUTPUT ACORN RESULTS RESULT GRAPHS

PRINT PRINTER FONT SIZE **10**

REPORTS

☐ YEAR 5 REPORT ☐ YEAR 10 REPORT ☒ YEAR 21 REPORT ☐ PREHARVEST REPORT

CLASS MIDPOINT	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	TOTAL
MIXED SPECIES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOGWOOD	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00
HICKORY	4.28	6.51	3.55	1.04	0.20	0.02	0.00	0.00	0.00	0.00	15.61
BLACKGUM	0.00	0.00	0.00	0.00	0.00	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	0.02	0.00	0.00	0.00	1.84
POST OAK	0.27	0.94	1.49	1.07	0.34	0.04	0.00	0.00	0.00	0.00	4.15
BLACKJACK OAK	0.02	0.11	0.30	0.42	0.31	0.11	0.02	0.00	0.00	0.00	1.29
BLACK OAK	0.03	0.18	0.61	1.32	1.85	1.76	1.16	0.56	0.20	0.05	7.73
SCARLET OAK	0.01	0.10	0.49	1.40	2.41	2.50	1.59	0.62	0.14	0.02	9.27
SOUTHERN RED OAK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NORTHERN RED OAK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OTHER OAKS	0.01	0.06	0.15	0.26	0.29	0.23	0.13	0.05	0.01	0.00	1.20
TOTAL ALL GROUPS	4.65	8.05	7.04	6.14	5.83	4.81	2.92	1.23	0.35	0.07	41.09

CLASS MIDPOINT	0.50	1.50	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	TOTAL
MIXED SPECIES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOGWOOD	56.38	96.96	125.73	79.59	11.37	0.08	0.00	0.00	0.00	0.00	370.11
SASSAFRAS	0.00	10.19	124.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	134.97
HICKORY	185.72	79.76	0.65	6.48	0.09	0.00	0.00	0.00	0.00	0.00	272.69
BLACKGUM	37.99	92.90	54.13	6.93	0.00	0.00	0.00	0.00	0.00	0.00	191.94
WHITE OAK	107.75	73.08	126.39	54.02	51.59	46.66	7.52	5.04	0.89	0.01	472.96
POST OAK	14.15	7.12	20.84	8.17	0.84	1.30	0.02	0.00	0.00	0.00	52.44
BLACKJACK OAK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PAGE SETUP

Make sure to select **LANDSCAPE** orientation first before changing margins. Suggested margin

settings are as follows: LEFT 15, RIGHT 10, TOP 20 and BOTTOM 20. Then click the OK button and a PRINT PREVIEW window will pop up.

Page Setup

Size: Letter 8.5"x11" 22x28cm

Source: Cassette

Orientation

☐ Portrait

☒ Landscape

Margins (millimeters)

Left: 15 Right: 10

Top: 20 Bottom: 20

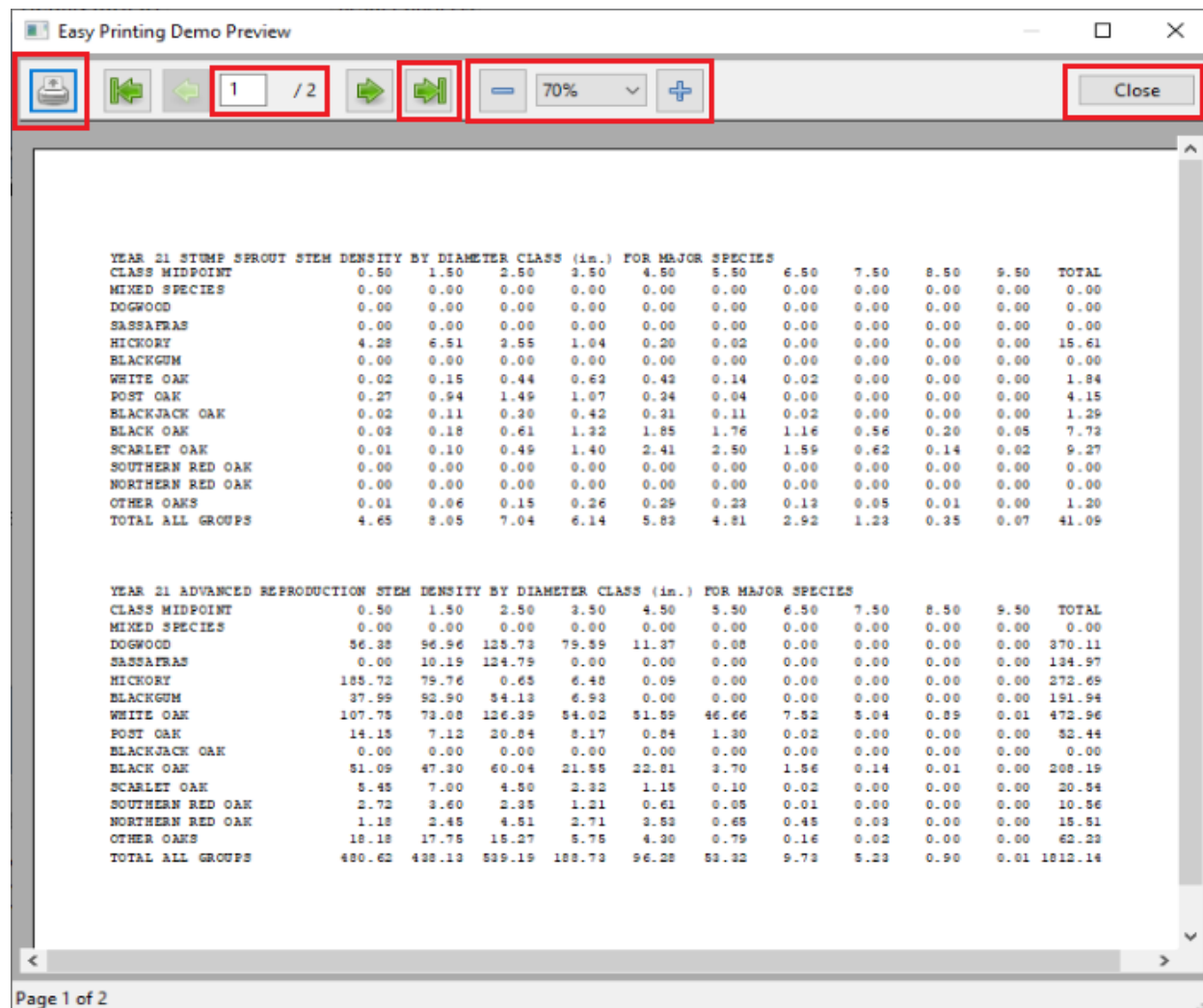
OK Cancel



PRINTING

The button at the top left corner will start the printing process. You can view either page if more than 1 page exists by using the green arrow to navigate between pages. You can use the – and + buttons to zoom in or out if you want to get a closer look at the table values. If you are

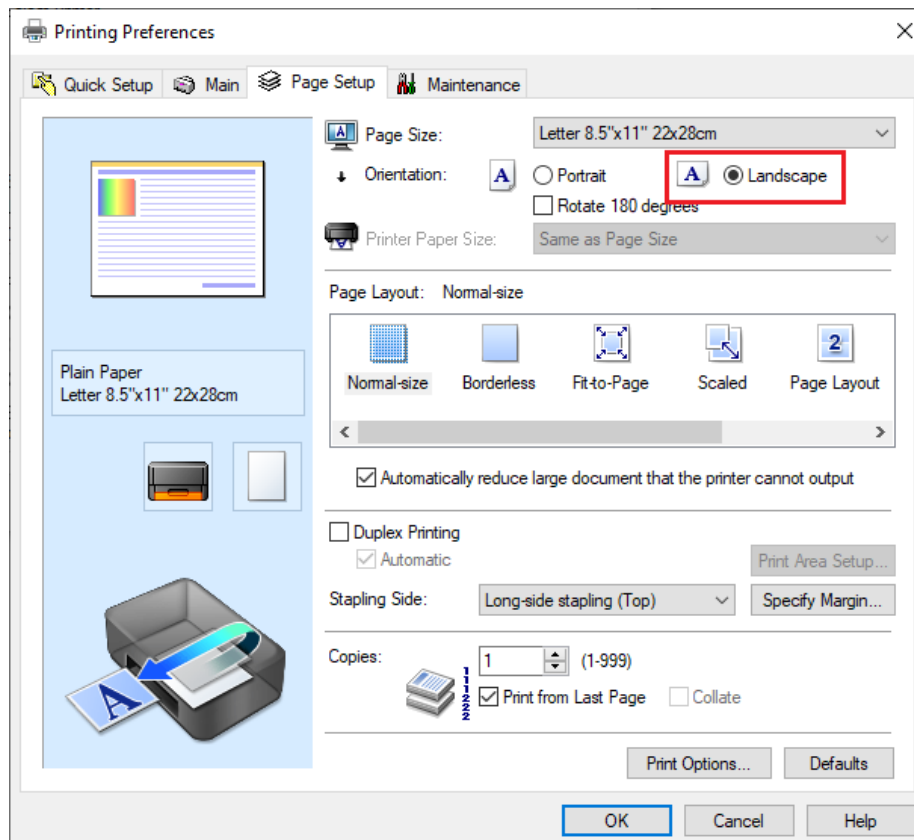
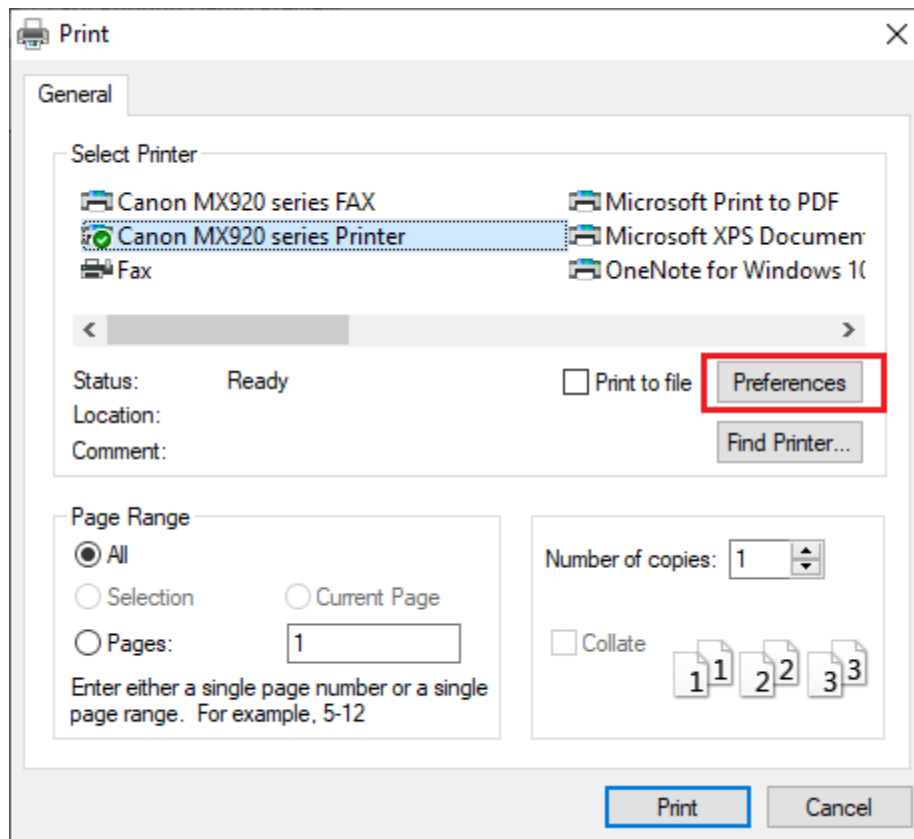
not satisfied with the table page preview press the CLOSE button and then start again with the PRINT button on the RESULTS REPORTS tab. The suggested values for font size and margins will work with most tables. Once you're satisfied with the page layout, press the button that has a picture on it on the upper left corner of the tab.



The PRINTER SELECTION window will then pop up and your printer can be selected. Once you select your printer it's a good idea to check the preferences and ensure the LANDSCAPE

orientation is selected. Once you're satisfied, press the PRINT button at the bottom of the page and printing should commence.

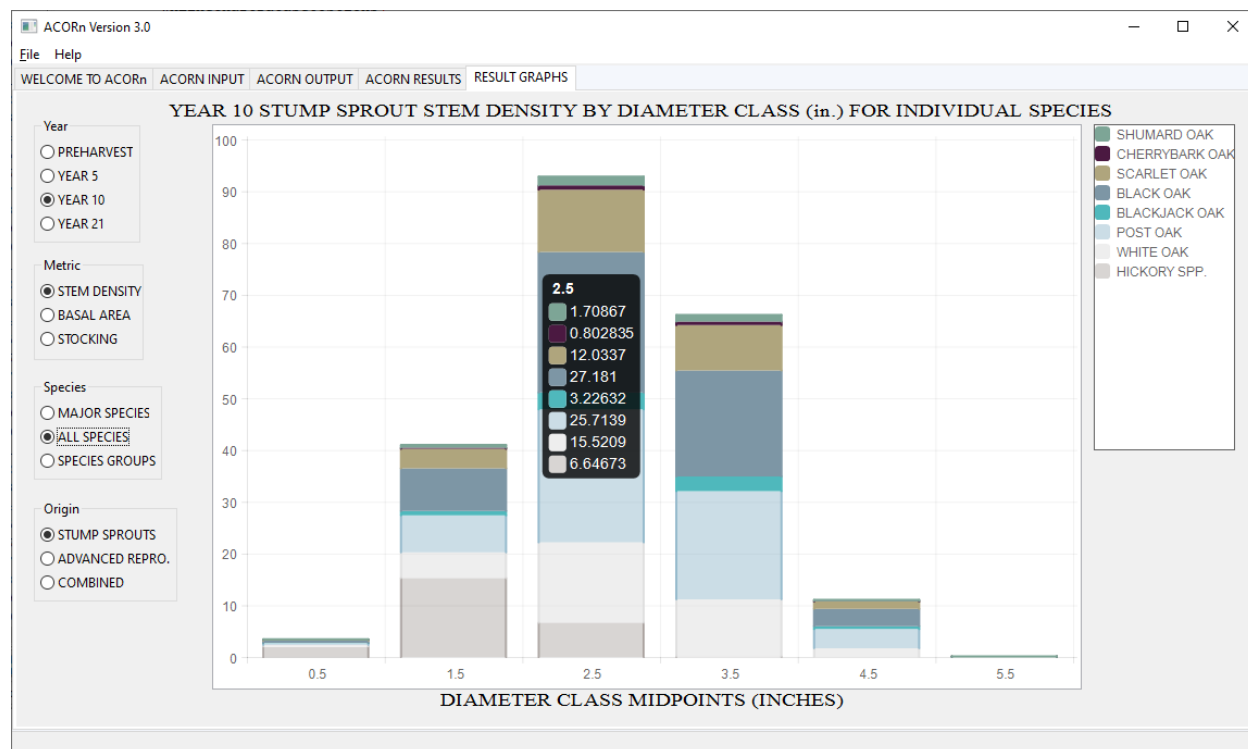




GRAPHS

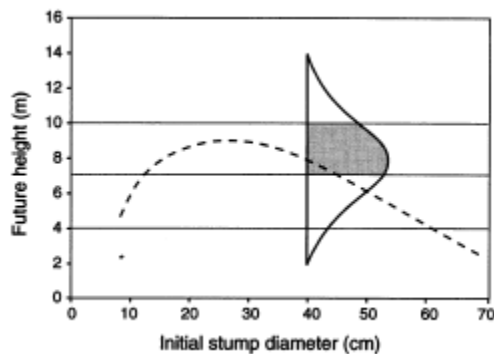
The final tab is the RESULT GRAPHS. It is not necessary to write output tables on the previous ACORn RESULTS tab in order to view graphs on this tab. The user only needs to select the input files on the ACORn INPUT tab then press the RUN/DONE button on the ACORn OUTPUT tab to view the graphs. There are 4 choice boxes along the left hand side of the page that allow the user to select any one of the 66 table outputs available in ACORn. They are similar to the choices available to the user on the previous ACORn RESULTS tab. When PREHARVEST is selected the ORIGIN choice box is grayed out because the graphs displayed are for the original stand inventory and not for stump sprouts or advanced reproduction. Likewise when YEAR 5 is selected the

METRICS and the ORIGIN choice boxes are grayed out since the only choice available to the user is for stem density of stump sprouts by height class. When the user hovers the mouse cursor over a bar a black window with the bar values appears. There is no print option for the graphs but on the Windows system simply click on anywhere on the ACORn interface to make the ACORn interface active then simultaneously press keyboard buttons Ctrl (control), Alt (alternate) and PrtScn (Print Screen) this copies an image of ACORn to the clipboard. The user can then open, Notes, MS Word, Power Point, 3D Paint or any other graphic package and press the keyboard buttons Ctrl and v and the image will be pasted into your document. If you paste into 3D Paint you can crop the image to capture just the desired graph window.



THE ACORn MODEL

The Acorn model was developed from long-term datasets collected by the USDA Forest Service, Northern Research Station. The data was collected in the Missouri Highlands under the supervision of multiple USFS scientists. Model development was performed by Daniel C. Dey as part of his PhD dissertation (Dey 1991). The original software was published in 1996 (Dey et al 1996) in the Canadian Journal of Forestry. Version 3.0 attempts updates the earlier software version to 2020 operating systems. ACORn is developed on a probabilistic interpretation of nonlinear regression. Typically regression model yield an average predicted value based on independent covariates. ACORn expands the interpretation of this average response by utilizing the variation about the average response. So in addition to the average response additional responses that are normally distributed about the average are estimated (Dey et al 1996).



For stump sprouts ACORn calculates and combines 2 probabilities, the probability of stump sprouting and the probability of survival and estimates the growth of those sprouts over time. At year 5 sprout height class is estimated at years 10 and 21 sprout diameter classes are estimated by species. For advanced reproduction, the probability of survival and tree growth are estimated at years 10 and 21. The additional metrics of basal area (ft. /acre) and percent stocking are determined at years 10 and 21 based on stem density and diameter distribution. Percent stocking estimates are use methods described by Arner et al. (2001). Model users are encouraged to review Dey et al. (1996) for full model description. Modelled species are listed in the appendix below. Other species not modelled should be included in the data collection and should be considered in the decision whether the ACORn model is applicable to the stand.

LITERATURE CITED

Dey, D.C., 1991. A comprehensive Ozark regenerator. Ph.D. dissertation. University of Missouri, Columbia, MO.

Dey, D.C., Johnson, P.S. and Garrett, H.E., 1996. Modeling the regeneration of oak stands in the Missouri Ozark Highlands. *Can. J. For. Res* 26:573-583.

Arner, S.L., Woudenberg, S., Water, S., Vissage J., MacLean C., Thompson M. and Hansen M., 2001. National algorithms for determining stocking class, stand size class and forest type for forest inventory and analysis plots. Internal Report, Newtown Square, PA, fia.fs.fed.us.

APPENDIX - DATA COLLECTION FORMS AND FILES

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 a shelterwood final removal). Before treatment, information must be collected on the number, size and species of overstory trees and advanced 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. Species modelled are listed in the species list below. Other species not modelled should be included in the data collection and should be considered in the decision whether the ACORn model is applicable to the stand.

SPECIES LIST:

HICKORY SPP.
PIGNUT HICKORY
WATER HICKORY
BITTERNUT HICKORY
PECAN
BLACK HICKORY
SHAGBARK HICKORY
SHELLBARK HICKORY
MOCKERNUT HICKORY
WHITE OAK
POST OAK
BLACKJACK OAK
BLACK OAK
SCARLET OAK
SOUTHERN RED OAK
NORTHERN RED OAK
CHINKAPIN OAK
SWAMP WHITE OAK
BUR OAK
SWAMP CHESTNUT OAK
DELTA POST OAK

CHESTNUT OAK

PIN OAK

NORTHERN PIN OAK

CHERRYBARK OAK

SHINGLE OAK

OVERCUP OAK

WATER OAK

NUTTALL OAK

WILLOW OAK

SHUMARD OAK

DOGWOOD

SASSAFRAS

BLACKGUM

WATER TUPELO

BLACK TUPELO

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

[illegible][illegible]

Overstory Input data file

Input data file derived from preharvest inventory of stems ≥ 1.6 inches D.B.H. used for calculating stump sprouting probability as well as survival and growth. Input data files should contain a header line and COLUMNS MUST BE IN THE ORDER LISTED.

stand_no	stand_age	site_index	plot_no	plot_size	species_code	tree_dbh
1	70	63	1	0.05	835	8.7
1	70	63	1	0.05	837	9.8
1	70	63	1	0.05	835	11.8
1	70	63	1	0.05	835	9.7
1	70	63	1	0.05	835	9.8
1	70	63	1	0.05	837	15
1	70	63	1	0.05	835	6.6
1	70	63	1	0.05	837	12
1	70	63	1	0.05	802	11.6
1	70	63	1	0.05	400	7.7
1	70	63	1	0.05	802	15.7
1	70	63	2	0.05	837	8.8
1	70	63	2	0.05	837	10
1	70	63	2	0.05	837	13.8
1	70	63	2	0.05	837	9
1	70	63	2	0.05	837	10.8
1	70	63	2	0.05	835	9.7
1	70	63	2	0.05	837	10
1	70	63	2	0.05	837	12

Advanced Reproduction Data Form

Stand_No	Date	Sheet ____ of ____						
Plot_Size(ac)	Stand_Aspect code	Stand_Slope position code						
Note: Include all sampled plots even if they have no advanced reproduction								
Plot_No	Species_ Code	Basal diameter to nearest 0.1"	Height to nearest 0.1'	Slope aspect code for plot	Slope position code for plot	Radii for common plot sizes		
						Radius	Plot_size	
						(ft)	(ac)	Plots/ac
						3.7	0.001	1000
						8.3	0.005	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 degrees		
						2=Azimuth 0 to 90 degrees		
						3=All others		
						Slope Position Codes		
						1 = Upper 1/3 and narrow ridgetops		
						2=Middle 1/3 or < 10% slope		
						3=Lower 1/3 and bottoms		
						Species Codes		
						110	Shortleaf Pine	
						316	Red Maple	
						400	Hickory (all species)	
						402	Bitternut Hickory	
						403	Pignut Hickory	
						405	Shellbark Hickory	
						407	Shagbark Hickory	
						409	Mockernut Hickory	
						491	Flowering Dogwood	
						694	Blackgum	
						802	White Oak	
						806	Scarlet Oak	
						812	Southern Red Oak	
						813	Cherrybark Oak	
						824	Blackjack Oak	
						826	Chinkapin Oak	
						833	Northern Red Oak	
						834	Shumard Oak	
						835	Post Oak	
						837	Black Oak	
						931	Sassafras	

Advanced Reproduction Input Data File

Input data file derived from preharvest advanced reproduction inventory of stems < 1.6 inches D.B.H. used for calculating advanced reproduction growth and survival. Input files can be created in a spreadsheet program and saved as a text file (.txt). Input data files should contain a header line and COLUMNS MUST BE IN THE ORDER LISTED.

stand_no	stand_aspect	stand_slope	plot_no	plot_size	plot_aspect	plot_slope	species_code	basal_diameter	tree_height	
1	3	1	1	0.004	3	1	931	0.116	1	
1	3	1	1	0.004	3	1	931	0.116	1	
1	3	1	1	0.004	3	1	931	0.254	2	
1	3	1	1	0.004	3	1	931	0.254	2	
1	3	1	1	0.004	3	1	931	0.944	7	
1	3	1	1	0.004	3	1	837	0.265	1	
1	3	1	1	0.004	3	1	837	0.265	1	
1	3	1	1	0.004	3	1	837	0.593	3	
1	3	1	1	0.004	3	1	491	1.244	8	
1	3	1	1	0.004	3	1	400	0.715	4	
1	3	1	2	0.004	3	1	931	0.116	1	
1	3	1	2	0.004	3	1	931	0.116	1	
1	3	1	2	0.004	3	1	931	0.116	1	
1	3	1	2	0.004	3	1	931	0.116	1	
1	3	1	2	0.004	3	1	931	0.254	2	
1	3	1	2	0.004	3	1	931	0.254	2	
1	3	1	2	0.004	3	1	931	0.254	2	
1	3	1	2	0.004	3	1	931	0.392	3	

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