

NCSU – Managed Pine Plantation (Hafley & Smith) Model

NCSU – Hafley & Smith

- Work began in the 80's to solve the disparity between published yield tables and long term spacing studies
- Computer version first developed for Apple II Plus computer with a companion version in FORTRAN for IBM 370 computer.
- Initially developed as unthinned loblolly pine plantation model
- Subsequently developed thinning model

NCSU – Hafley & Smith

- Based on spacing studies from NC, LA, SC, S. IL. and Union Camp Corp. growth plots
- Initially only loblolly pine, now also white pine
- Data Ranges:
 - Geographic Range (S. IL, NC, SC, LA)
 - Site Index (25): 50 to 90
 - Age: 5 to 45
 - Density (tpa): 4x4 (2722 tpa) to 21x21 (99 tpa)

NCSU – Hafley & Smith

- Height-over-age drives the model
 - H_D (dominant height) = average ht of tallest 100 surviving trees per acre
- Stand parameters are estimated from H_D
- Diameter and height distributions are determined from the stand parameters
- Johnson's S_{BB} distribution used to model diameter and height

NCSU – Hafley & Smith

- H_U (max ht) = $f(SI, A, S)$
- H_L (min ht), H_M (modal ht) = $f(H_U, A, S)$
- D_U (max dia) = $f(H_D, S)$
- D_L (min dia), D_M (modal dia) = $f(D_U, H_D, S)$
- S_H (std dev ht) = $f(A, S)$
- S_D (std dev dia) = $f(H_D, S)$
- Mortality = $f(TPA, S, A)$
- Volume = $f(D, H) = a + b (D^2H)$
- Where:
 - SI = Site Index (base age 25)
 - A = Stand Age
 - S = growing space per tree = 43560/TPA

NCSU – Hafley & Smith

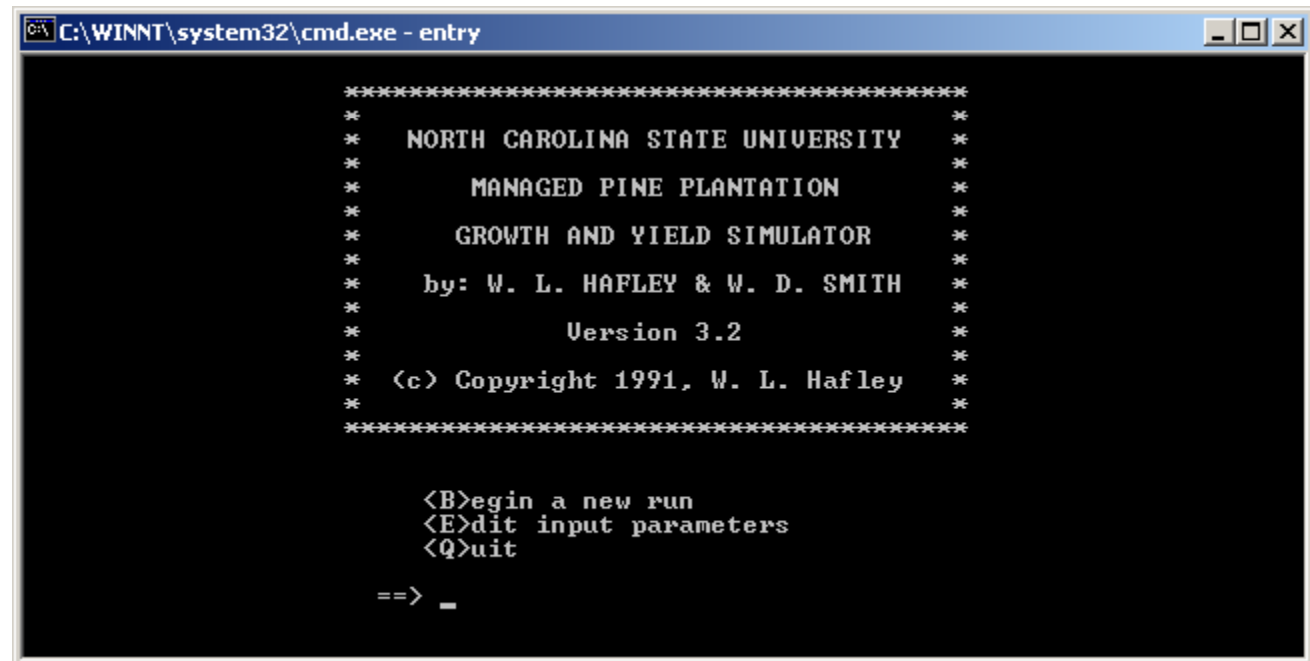
- Thinning:
 - Thinning from below – truncates dist. based on ht
 - Row thinning – just reduce tpa
- Growth response – growth rate of thinned stand is equal to growth of unthinned stand at same height and tpa
- Comparison to 8 thinning studies
 - AR, LA, TN, MS, SC, MD
 - 90% of comparisons showed no significant difference between studies and model using K-S test

NCSU – Hafley & Smith Model

- North Carolina State University, Managed Pine Plantation, Growth & Yield Simulator Version 3.2, by W. L. Hafley & W. D. Smith - (c) Copyright 1991, W. L. Hafley
- Interface is dated and difficult to use
- NCSU Extension Forestry believes an improved interface will make the model more useful.

NCSU - Hafley & Smith Model

- Original Version 3.2 Interface:
 - MS-DOS program written in Turbo Pascal
 - Screen and/or LPT1 output



```
C:\WINNT\system32\cmd.exe - entry

*****
*      NORTH CAROLINA STATE UNIVERSITY      *
*      MANAGED PINE PLANTATION              *
*      GROWTH AND YIELD SIMULATOR          *
*      by: W. L. HAFLEY & W. D. SMITH      *
*      Version 3.2                          *
*      (c) Copyright 1991, W. L. Hafley    *
*****

      <B>egin a new run
      <E>dit input parameters
      <Q>uit

==> _
```

NCSU - Hafley & Smith Model

```

C:\WINNT\system32\cmd.exe - entry
*****
* NORTH CAROLINA STATE UNIVERSITY *
* MANAGED PINE PLANTATION *
* GROWTH AND YIELD SIMULATOR *
* by: W. L. HAFLEY & W. D. SMITH *
* Version 3.2 *
* (c) Copyright 1991, W. L. Hafley *
*****

<B>egin a new run
<E>dit input parameters
<Q>uit

==> _
    
```

```

C:\WINNT\system32\cmd.exe - entry

WHAT SPECIES DO YOU WANT TO PROCESS?
!!! loblolly pine
!!! white pine
====>
    
```

```

C:\WINNT\system32\cmd.exe - entry

site index
<1> base age 25?
<2> base age 50?

DEFAULT : base age 25 ==>
    
```

```

C:\WINNT\system32\cmd.exe - entry

AVAILABLE HEIGHT/AGE CURVES:

<1> lower coastal plain/wet site
<2> upper coastal plain
<3> piedmont/upland
<4> enter/remove a curve

<0> use/remove a set of Ht/Age coordinates

DEFAULT : piedmont/upland ==> _
    
```

```

C:\WINNT\system32\cmd.exe - entry

There are three types of conditions
from which the program may be started:
1) the initial conditions at stand
establishment,
2) the stems per acre at a known point
point in time, or
3) the stems per acre and either basal
area per acre or quadratic mean
diameter at a known point in time.
ENTER 1,2 OR 3 -- DEFAULT : 1 ==>
    
```

```

C:\WINNT\system32\cmd.exe
D:\Work\Project\NCSU\HAFLEY\1\NCSU-M2\main
NORTH CAROLINA STATE UNIVERSITY PLANTATION MANAGEMENT SIMULATOR

Y I E L D T A B L E < Loblolly Pine >
-----
SITE INDEX      PLANTING DENSITY      PERCENT PLANTING      INITIAL SURVIVAL
<BASE AGE 25 > <STEMS/ACRE>        <STEMS/ACRE>          <STEMS/ACRE>
65.0            700                    85                     595
-----
AGE  DOM   AUE   AUE   BASAL  TOTAL  PINE   PINE   PINE
yrs  HGT   HGT   DIA   AREA  VOLUME HDWD   HDWD   MAI   PAI
     ft   ft   in   sq ft cu ft(ib) cu ft(ib)
-----
5    16   594   2.2   14.1   15     0     79     0     16   16
10   33   591   4.9   30.1   78     0     850    0     85   154
15   47   572   6.6   42.0   134    0     2025   0     135  235
20   57   532   7.6   51.3   169    0     3123   0     156  220
25   66   482   8.4   58.8   187    0     3956   0     158  167
30   73   430   9.1   65.1   193    0     4503   0     150  109
35   79   381   9.6   70.4   193    0     4891   0     140   78
-----
NOTE: HEIGHT/AGE CURVE - PIEDMONT/UPLAND

D:\Work\Project\NCSU\HAFLEY\1\NCSU-M2>
    
```

NCSU - Hafley & Smith Model

- New Windows Interface:

- Windows interface runs modified version (only input/output modified) of Turbo Pascal model to ensure the same simulation results.
- Output to html or csv
- Html output can include charts.

The screenshot shows a Windows-style application window titled "NCSU-Managed Pine Plantation (Hafley & Smith) Model". The interface is organized into several panels:

- Run Name:** A text box containing "Default".
- Select Species:** Two radio buttons, "Loblolly pine" (selected) and "White pine".
- Initial Conditions:** A dropdown menu set to "TPA at establishment". Below it, a table with columns "TPA:", "Age:", "Size:", and "Survival:". The "TPA:" cell contains "700" and the "Survival:" cell contains "85".
- Hardwood:** A dropdown menu set to "None". Below it, two text boxes labeled "% total BA:" and "At Age:".
- Site Index:** Two radio buttons, "Base Age 25" (selected) and "Base Age 50". Below them, a text box for "Site Index Value:" containing "65". At the bottom, a dropdown menu for "Height/Age Curve:" set to "piedmont/upland".
- Fusiform:** A checkbox "Enable" (unchecked). To its right, three text boxes: "Infection %:" (empty), "at Age:" (containing "5"), and "Hazard rating:" (empty). A "View Map" button is located below the "Enable" checkbox.
- Thinnings:** A checkbox "Enable Thinnings" (unchecked). Below it, a table with columns "Age:" and "Type of thinning:". A large empty text area is provided for entries. To the right of this area are "Add" and "Delete" buttons.
- Output Options:** A section for "Output to: HTML". Below it, a "Report Interval:" section with three text boxes: "Start" (containing "5"), "End" (containing "35"), and "Interval" (containing "5").

At the bottom of the window, there is a row of six buttons: "Run", "Help", "Load", "Save", "Configuration", and "Exit".

NCSU – Hafley & Smith Model

- Output options: Web page (html) or Excel (csv)

NORTH CAROLINA STATE UNIVERSITY - Managed Pine Plantation (Hafley & Smith) Model - Microsoft Internet Explorer

Address: D:\Work\Project\NCSU\HafleySmith\NCSU-MPP-HS\debug\NCSU-MPP-HS.html

NORTH CAROLINA STATE UNIVERSITY PLANTATION MANAGEMENT SIMULATOR

YIELD TABLE (Loblolly Pine)

SITE INDEX PLANTING DENSITY PERCENT PLANTING INITIAL SURVIVAL
 (BASE AGE) (STEMS/ACRE) SURVIVAL (STEMS/ACRE)

65.0 450 85 595

DOM AVE AVE BASAL AREA TOTAL VOLUME PINE
 AGE HGT TPA DIA HGT PINE HDWD PINE HDWD MAI PAI
 (yrs) (ft) (in) (ft) (sq ft) (cu ft - ib)

Age	Dom Heig	TPA	Dia	Ave Ht	Pine BA	Hdwd BA	Pine Vol	Hdwd Vol	MAI	PAI
5	16	382	2.3	14.6	11	0	59	0	12	12
10	34	382	5.4	31.0	60	0	667	0	67	122
15	47	377	7.2	43.3	107	0	1665	0	111	200
20	58	367	8.4	52.8	143	0	2706	0	135	208
25	67	350	9.3	60.5	167	0	3629	0	145	185
30	74	330	10.1	66.9	182	0	4377	0	146	149
35	80	308	10.6	72.4	190	0	4943	0	141	113
40	86	286	11.1	77.2	193	0	5347	0	134	81
45	91	257	11.7	81.4	193	0	5653	0	126	61
50	95	235	12.3	85.2	193	0	5923	0	118	54
55	98	217	12.8	88.6	194	0	6165	0	112	48
60	102	203	13.2	91.8	194	0	6383	0	106	44
65	105	191	13.6	94.7	194	0	6583	0	101	40

Microsoft Excel - NCSU-MPP-HS.csv

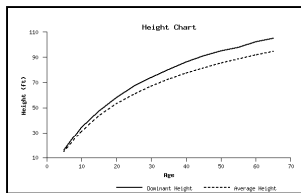
Age	Dom Heig	TPA	Dia	Ave Ht	Pine BA	Hdwd BA	Pine Vol	Hdwd Vol	MAI	PAI
5	16	382	2.3	14.6	11	0	59	0	12	12
10	34	382	5.4	31.0	60	0	667	0	67	122
15	47	377	7.2	43.3	107	0	1665	0	111	200
20	58	367	8.4	52.8	143	0	2706	0	135	208
25	67	350	9.3	60.5	167	0	3629	0	145	185
30	74	330	10.1	66.9	182	0	4377	0	146	149
35	80	308	10.6	72.4	190	0	4943	0	141	113
40	86	286	11.1	77.2	193	0	5347	0	134	81
45	91	257	11.7	81.4	193	0	5653	0	126	61
50	95	235	12.3	85.2	193	0	5923	0	118	54
55	98	217	12.8	88.6	194	0	6165	0	112	48
60	102	203	13.2	91.8	194	0	6383	0	106	44
65	105	191	13.6	94.7	194	0	6583	0	101	40

Output can be printed, saved, reformatted, or have additional calculations performed (Excel).

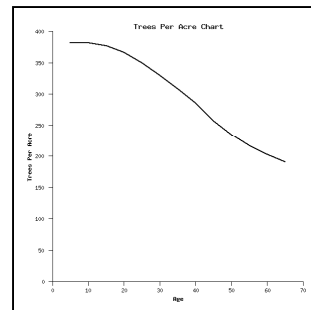
NCSU - Hafley & Smith Model

- Web page output can include a variety of charts:

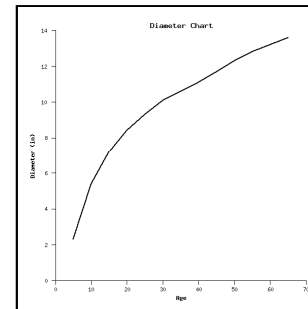
Height



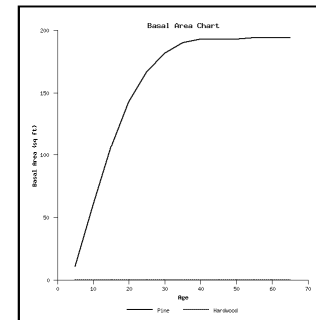
Trees per Acre



Diameter

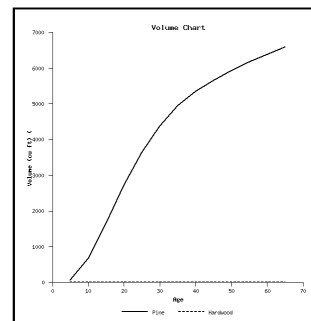


Basal Area

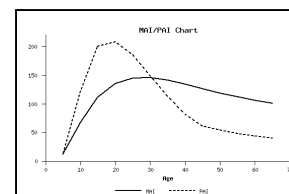


Charts can be turned on/off to customize the web page output.

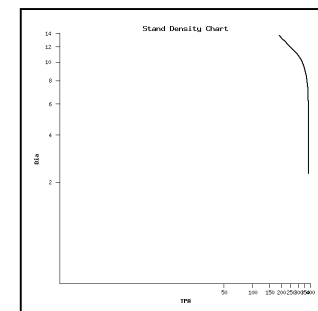
Volume



MAI/PAI

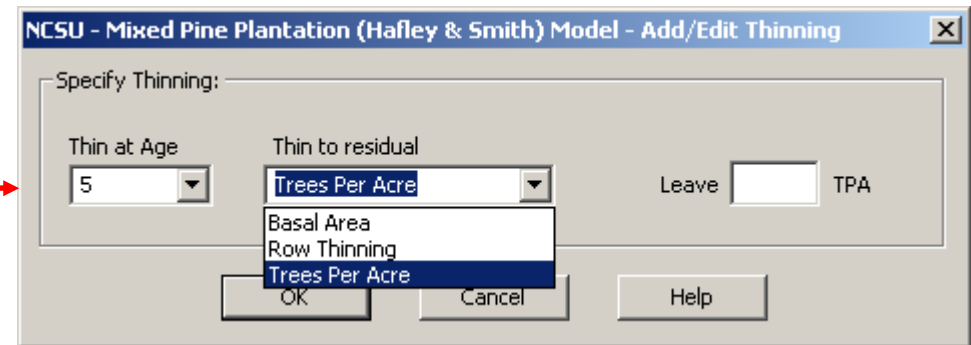
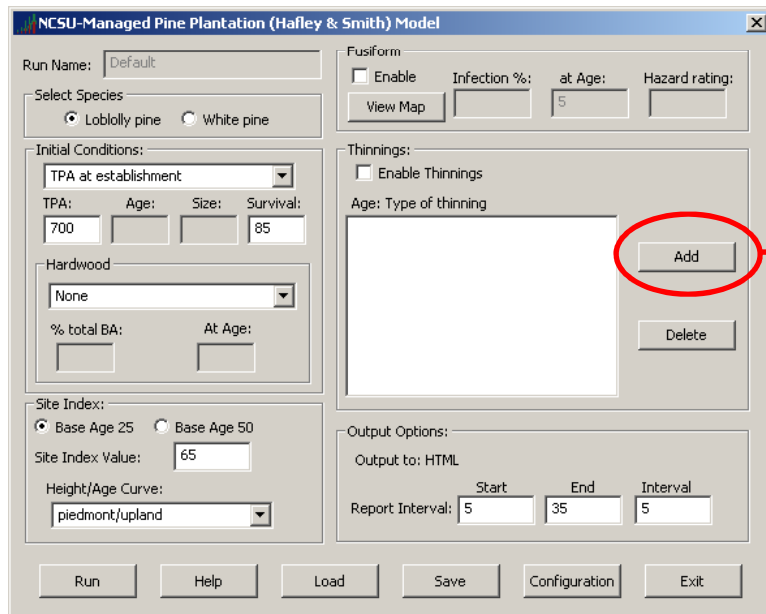


Stand Density



NCSU – Hafley & Smith Model

- Thinnings are specified by clicking the Add button and then selecting the type of thinning from Specify Thinning dialog.

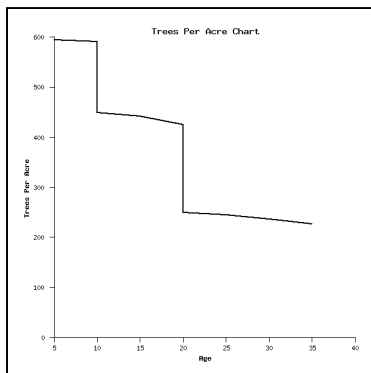


Remember to select the year for the thinning and to fill in the thinning target (TPA, Basal Area, or rows).

NCSU - Hafley & Smith Model

Example run with two thinning treatments.

Trees per Acre



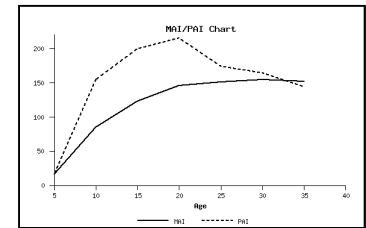
NORTH CAROLINA STATE UNIVERSITY PLANTATION MANAGEMENT SIMULATOR

YIELD TABLE (Loblolly)

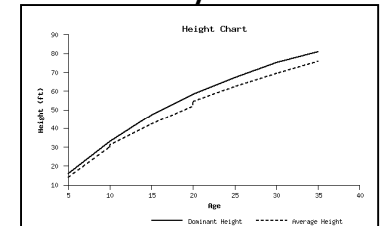
SITE INDEX (BASE AGE 25)		PLANTING DENSITY (STEMS/ACRE)		PERCENT SURVIVAL		PLANTING SURVIVAL (STEMS/ACRE)		INITIAL SURVIVAL (STEMS/ACRE)		
65.0		700		85		595		595		
AGE (yrs)	DOM (ft)	HGT (ft)	TBA (in)	AVE DIA (in)	AVE HGT (ft)	BASAL PINE (sq ft)	AREA HDWD (cu ft)	TOTAL PINE (cu ft)	VOLUME HDWD (cu ft)	MAI PAI
5	16	594	2.2	14.1	15	0	79	0	16	16
10	33	591	4.9	30.1	78	0	850	0	85	154
10		142 TREES REMOVED						-114		-0
10	33	449	5.2	31.0	66	0	736	0		
15	47	442	6.9	42.2	114	0	1730	0	123	199
20	58	425	8.1	51.7	151	0	2803	0	146	215
20		174 TREES REMOVED						-800		-0
20	58	250	8.7	54.2	103	0	2003	0		
25	67	245	9.8	62.3	128	0	2873	0	151	174
30	75	237	10.7	69.4	148	0	3691	0	154	164
35	81	228	11.4	75.7	162	0	4410	0	152	144

NOTE: HEIGHT/AGE CURVE - PIEDMONT/UPLAND

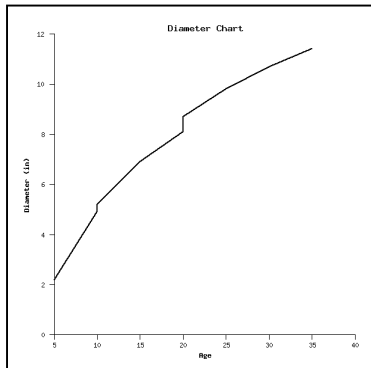
Height



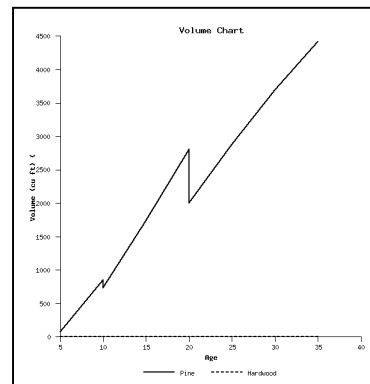
MAI/PAI



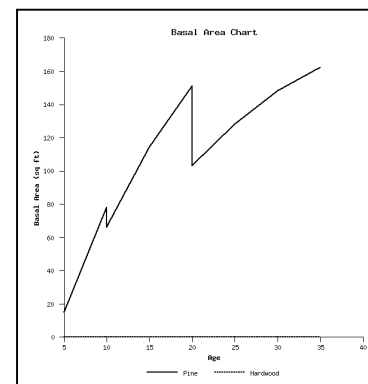
Diameter



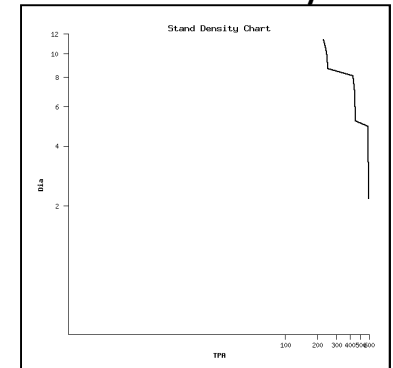
Volume



Basal Area

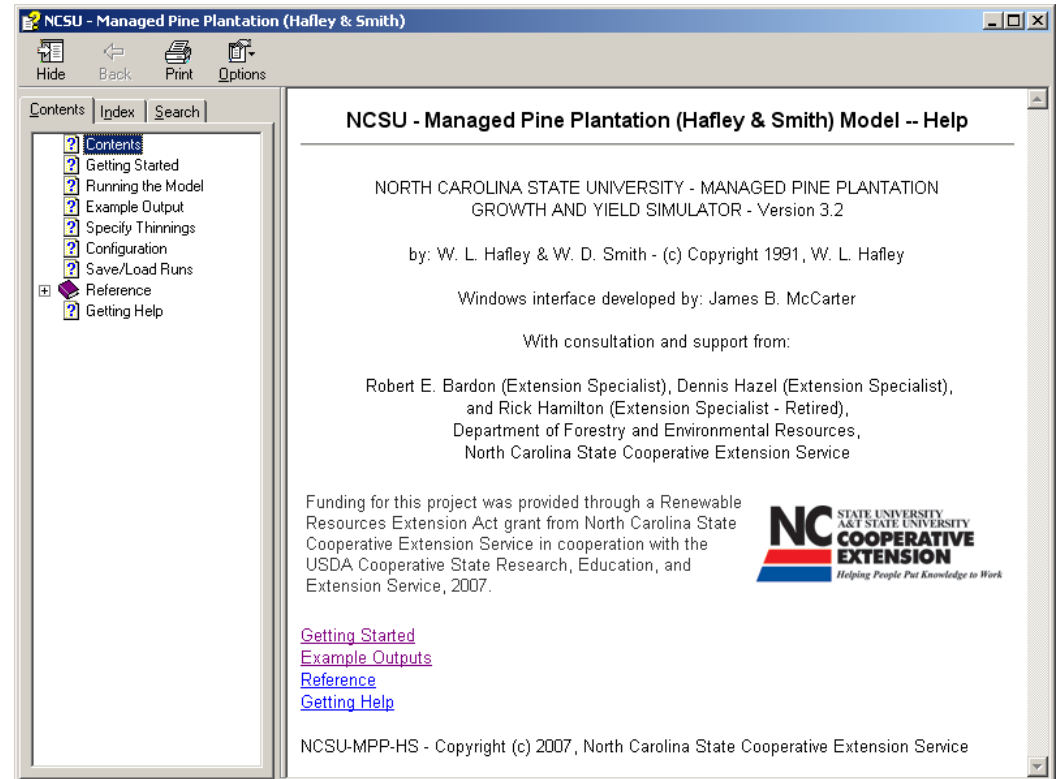


Stand Density



NCSU – Hafley & Smith Model

- The updated model comes with a help file that documents the features, interface, and details of implementation for the model.



NCSU – Hafley & Smith Model

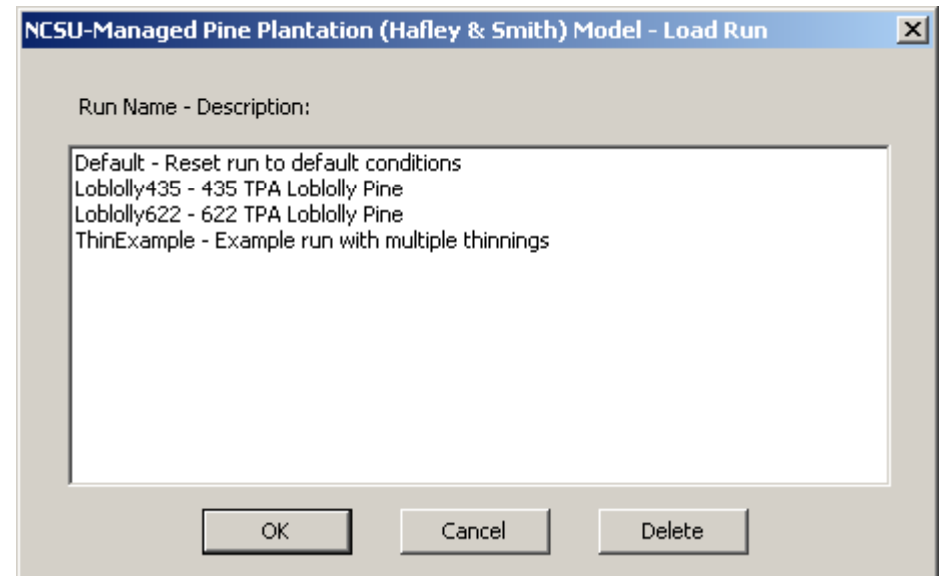
- The Windows interface can be configured for desired output and product specifications.

The screenshot shows a Windows configuration dialog box titled "NCSU-Managed Pine Plantation (Hafley & Smith) Model - Configuration". The dialog is divided into several sections:

- Output Options:** Two radio buttons are present: "Html Output (Internet Explorer)" (selected) and "CSV Output (Excel)".
- Charts:** A group box containing six checkboxes: "Height" (checked), "Tree Per Acre" (checked), "Diameter" (unchecked), "Basal Area" (unchecked), "Volume" (unchecked), and "MAI/PAI" (unchecked). "Density" is also listed but not checked.
- Run Original Model:** A button labeled "Run Original Model".
- Show Subprocess:** A checkbox labeled "Show Subprocess" (unchecked).
- Product Specifications:** A group box containing:
 - Three input fields for "Small End Diameter Inside Bark": "Sawtimber" (8.0), "Chip-N-Saw" (6.0), and "Pulpwood" (4.0).
 - A label "Variable Length Logs:" followed by "Up to" and an input field "24" and the unit "feet".
 - A label "Sawtimber Volume: MBF -" followed by a dropdown menu set to "Scribner".
 - A label "Pulpwood and Chip-N-Saw Volume:" followed by a dropdown menu set to "Cubic feet".
- Buttons:** "OK", "Cancel", and "Help" buttons at the bottom.

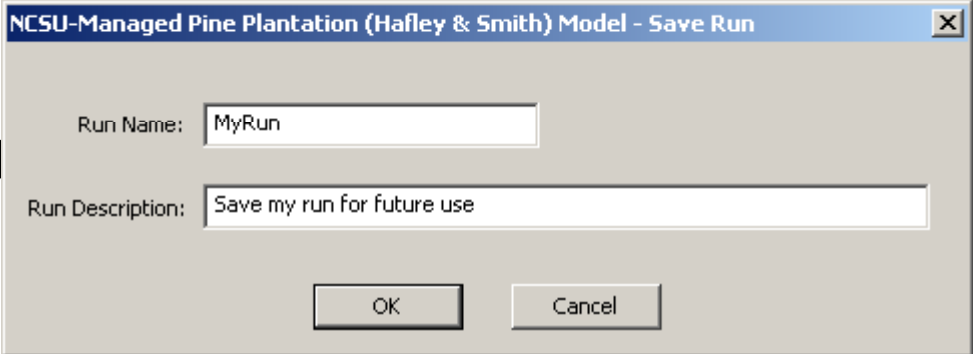
NCSU – Hafley & Smith Model

- Multiple “runs” can be saved and loaded in the future to quickly demonstrate various types of management.



NCSU – Hafley & Smith Model

- When saving a run the user will be prompted for a name and description.



NCSU-Managed Pine Plantation (Hafley & Smith) Model - Save Run

Run Name: MyRun

Run Description: Save my run for future use

OK Cancel

NCSU – Hafley & Smith Model

- Windows Interface developed by: James B. McCarter
- With consultation from: Robert E. Bardon, Dennis Hazel, Mark Megalos (Extension Specialists), and Rick Hamilton (Extension Specialist - Retired), Department of Forestry and Environmental Resources, North Carolina State Cooperative Extension Service.
- Funding for this project was provided through a Renewable Resources Extension Act grant from North Carolina State Cooperative Extension Service in cooperation with the USDA Cooperative State Research, Education, and Extension Service.
- Windows version is available from NCSU Extension Forestry:
 - <http://www.ces.ncsu.edu/nreos/forest/>