DENSITY MANAGEMENT DIAGRAMS…TOOLS AND USES

Murray E. Woods[1]

Density management diagrams (DMD's) have been developed for a wide range of North American tree species. They have proven to be an excellent exploratory tool in understanding the interaction of density, average tree volume and diameter within a forest stand. DMD's have been recently promoted as a suitable tool for determining timing and extent of stand thinning interventions. Unfortunately, the success of their adoption, due to their complexity, has been limited. To facilitate their acceptance and utilization, simple to use, interactive software has been developed. This paper will provide a brief review of the **Ontario Density Management Diagram – ODMD** software (Beta version).

Recent North American literature sources document many species-specific versions of density management diagrams (DMD's). Drew and Flewelling (1979) described and presented the generally adopted format for DMD's for their coastal Douglas-fir (*Pseudotsuga menziessii* (Mirb.) Franco var. *menziesii*) plantation diagram. This work has resulted in the development of DMD's for black spruce (*picea mariana* (Mill.) B.S.P.) (Newton and Weetman 1993), jack pine (*Pinus banksiana* (Lamb.) (Archibald and Bowling 1995), interior Douglas-fir, lodgepole pine (*Pinus contorta* Dougl.), white spruce (*Pica glauca* (Moench) Voss) (Farnden 1996), red pine *(Pinus resinosa* Ait.), and white pine (*Pinus strobus* L.) (Smith and Woods 1997).

This paper is an excerpt of a paper presented on density management diagrams at the Stand *Density Management Conference: Using the Planning Tools*, Edmonton, Alberta, Canada, November 23-24, 1998**.**

ONTARIO DENSITY MANAGEMENT DIAGRAM SOFTWARE

In an effort to have more people use DMD principles in developing silvicultural crop plans, intuitive and interactive software has been developed. The software *"Ontario Density Management Diagram – ODMD"* (Woods *et al.* 1998) (fig. 1) is a package that allows quick stand density management "gaming" scenarios to be calculated and evaluated. In what can take many minutes to calculate by hand on a paper version of a DMD, the ODMD software is able to provide accurate answers in seconds.

The program is written in Visual Basic™ and runs in the Windows 95™ or the Windows 98™ operating system.

The ODMD software has been developed in a book style format. Tabs along the right-hand margin of the screen identify pages within the book. Tabs appear and disappear as user interactive choices are selected throughout the program.

The title page is an introductory screen that gives the user the first look at the "book" design of the software. Other tabs can be selected and explored as they become activated and appear on the right-hand edge of the form.

As in the case with most programs written in the Windows™ framework, a comprehensive HELP system has been designed and built into the ODMD software (fig. 2).
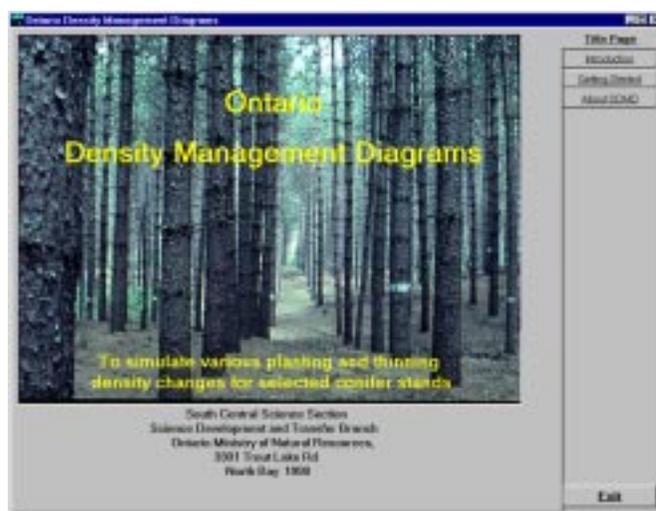

Figure 1.—

[1]*Growth and Yield Program Leader, Southcentral Sciences Section, Ontario Ministry of Natural Resources, 3301 Trout Lake Road, North Bay, ON P1A 3J7, Email: woodsm@Gov.on.ca*
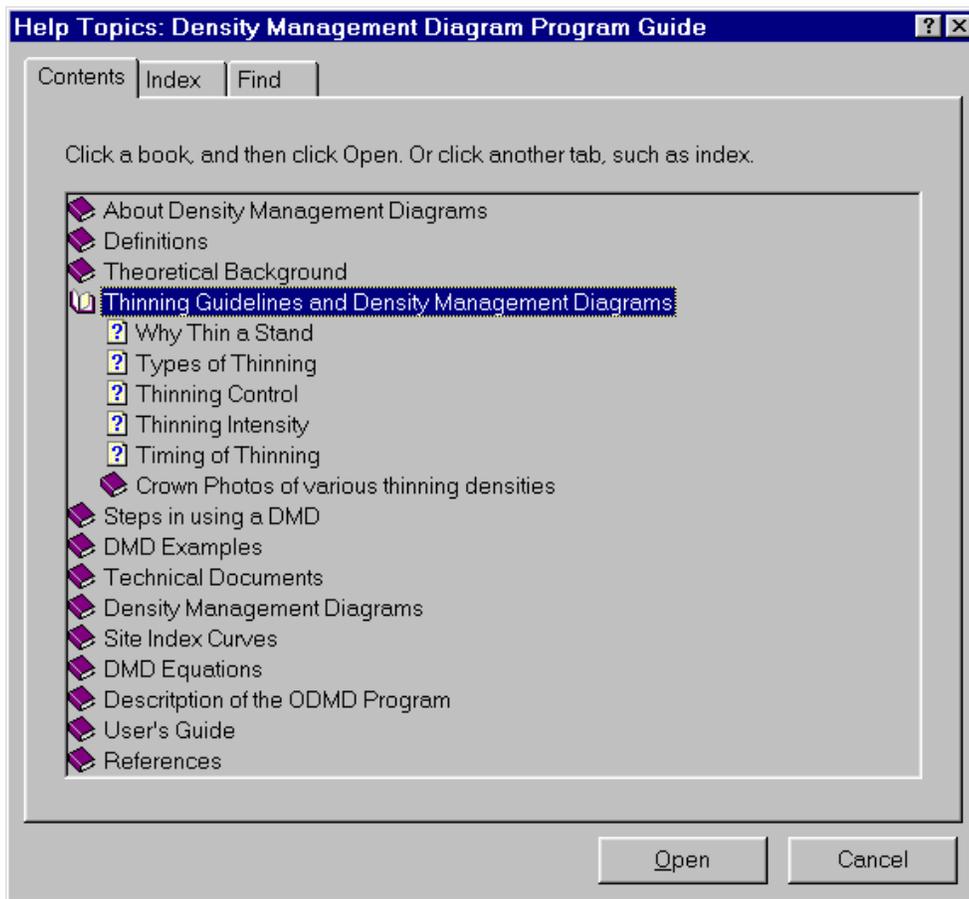
Figure 2.—

A "Table of Contents" system as well as a search "index" system is provided. Attribute definitions and detailed technical reports are provided on-line and can be printed at the user's request.

The Getting Started tab (fig. 3) accesses the key screen for the ODMD software. To move forward through the program three selections must be made:
· Region of the province
· Forest Type: Plantations or Natural Stands, using existing known stand parameter or enter field plot data.
· Species: white pine, red pine, jack pine, black spruce (draft)

PLANTATION ESTABLISHMENT

If a new plantation (fig. 4) is the modeling choice, the required information to proceed includes an estimate of site quality (site index), a spacing factor or planting density (each resetting the other to their corresponding value). Another way to set these parameters is to enter a desired average stand diameter at the time of required first thinning (relative-density = 0.55 point).

Specific soil/site relationships and other species suitability work for Northwestern Ontario has been built into the software. If soil condition or an alternate species was taken from the site, the software provides suitable site quality estimates to plan the next forest crop.

Computed stand estimates for top-height and age are presented for the plantation's recommended point of thinning. All values can be viewed graphically by selecting the *DMD Graph* Tab.

KNOWN STAND PARAMETERS

Direct entry into the ODMD model can be accomplished if measurements of stand density, quadratic mean diameter (DBHq), age, and top-height are known (fig. 5). The three required variables for the user to enter are stand age, density, and DBHq. The model computes stand top-height and, based on the entered stand age, site index. An average spacing and basal area is computed. An indication of the stand's competitive status is displayed as one of the zones introduced and explained earlier.

Because the ODMD is an average stand model, users should ensure that the model's estimation of stand top-height is similar to what was measured in the field. A measurement of model confidence can be attained by how similar the estimated top-height is to the actual measured top-height value.
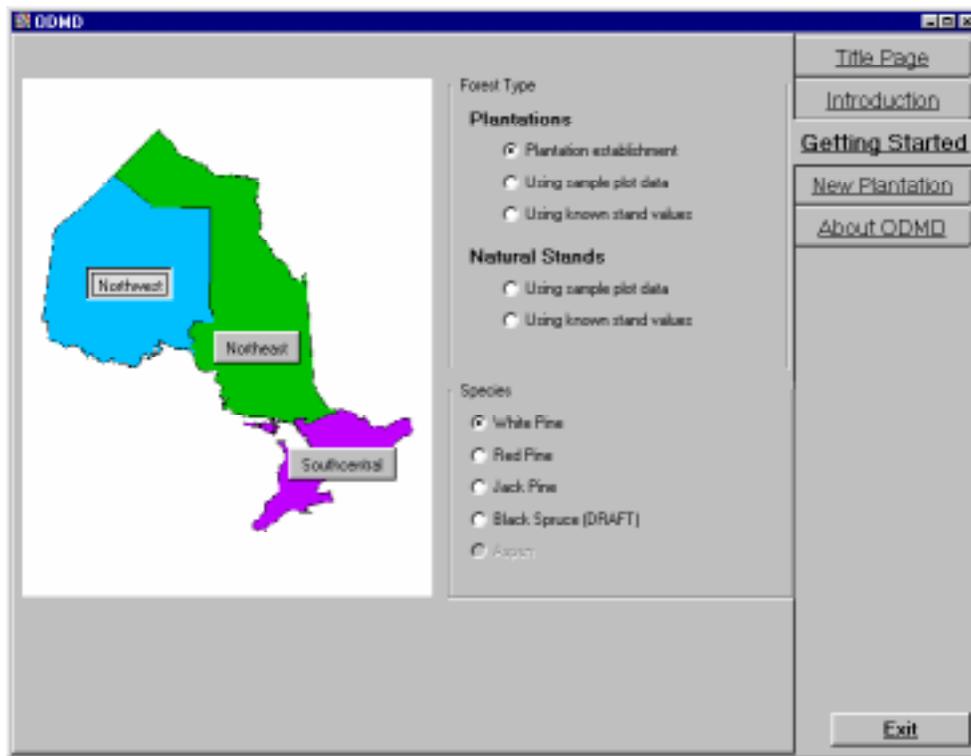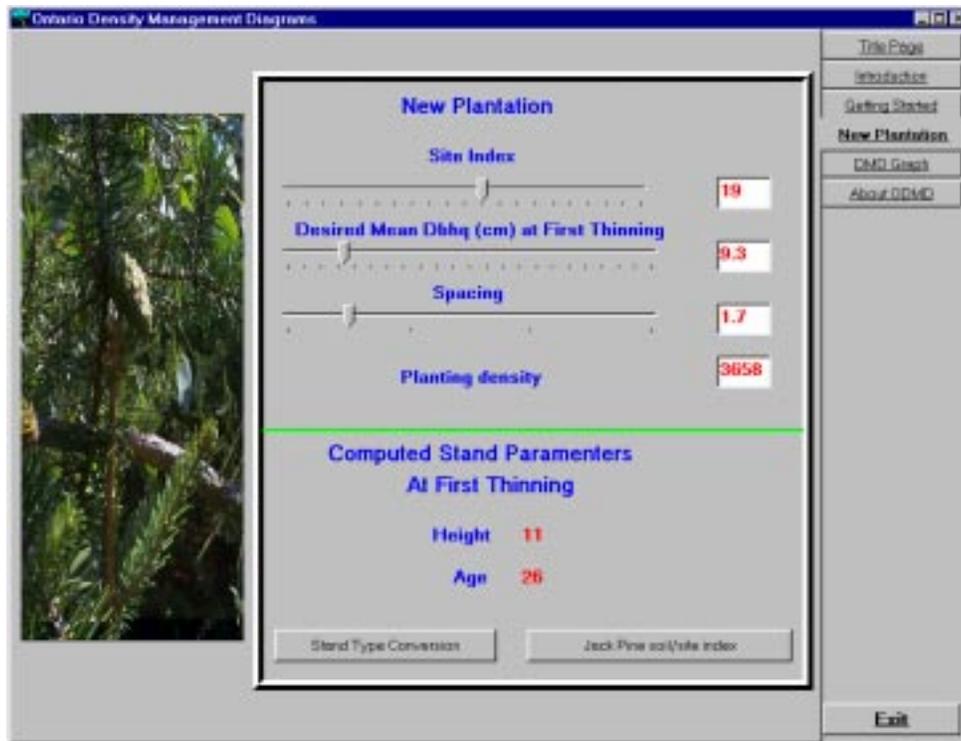
Figure 3.—*Getting Started menu options.*
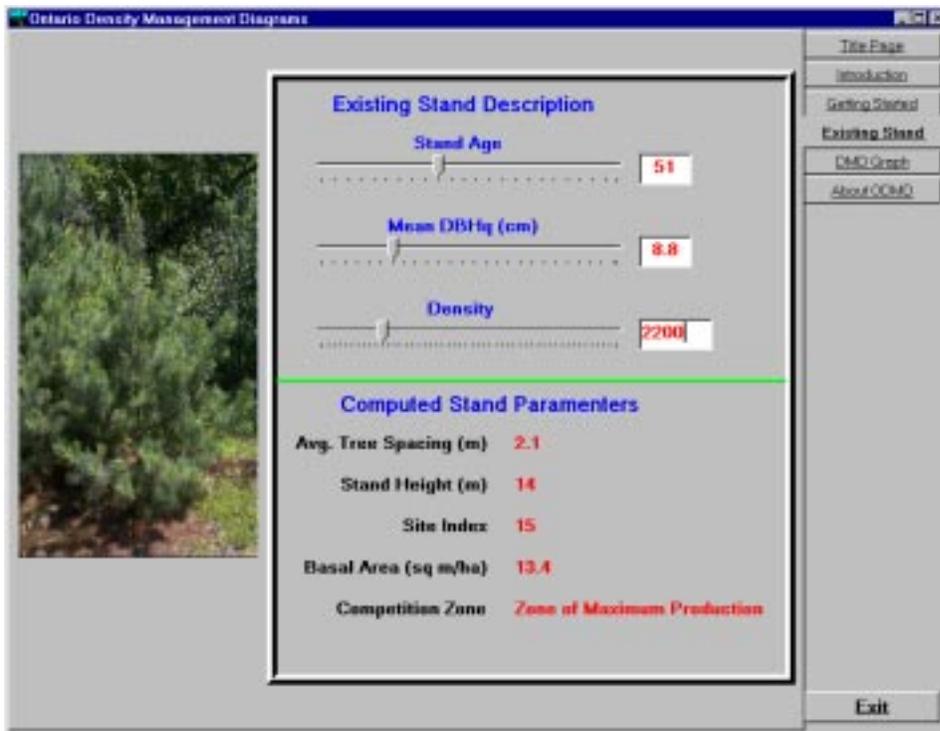

Figure 4.—*Plantation establishment.*

Figure 5.—

All values can be viewed graphically by selecting the *DMD Graph* Tab.

SAMPLE PLOT DATA

Selecting the *Sample Plot D*ata Tab allows the user to enter diameter measurements from fixed-area plots of known size and stand age. Stand summary values for each plot entered are presented and can be displayed on the ODMD by selecting the DMD Graph Tab. Aggregations of similar plots located within a stand can be made with this option. Individual crop plans can be completed for stratified areas within an individual plantation or natural stand.

DMD GRAPH

Entered stand data are presented on an electronic DMD (fig. 6). The diagram has been visually simplified by
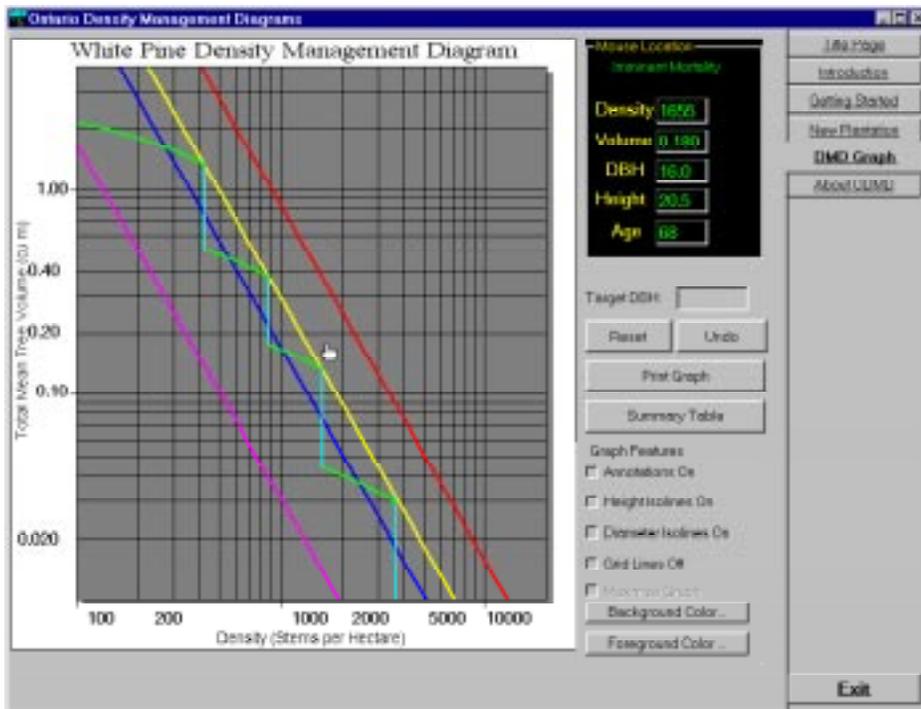

Figure 6.—*DMD Graph.*

removing the diameter and top-height isolines. In its place, a dynamic pointer has been added. As you move the pointer (a hand-shaped cursor), computed stand values are presented on the upper right hand portion of the screen. Top-height, diameter isolines, and zones of stand status can be displayed if chosen.

Thinning can be accomplished on the diagram by clicking with the left mouse button anywhere on the diagram above the green line (indicating a harvest) and outside *the "Zone of Imminent Competition and Mortality."* Multiple thinning interventions can be simulated on the diagram. Any or all thinnings can be removed by clicking on the "*Undo*" button. Selecting and clicking on the "Reset" button will allow the user to start over from the originally entered parameter position.

A copy of the diagram can be printed to any connected printer by selecting the print button.

TABLE SUMMARY

A tabular summary of pre- and post-thinning scenarios can be viewed and printed (fig. 7). This table can be personalized and added to the crop plan file.

SUMMARY

The use of density management diagrams by resource managers in Ontario has been limited. Some of the reluctance to use this tool has been due to the perceived complexity of the paper-based multi-line diagram form. The recent development of the ODMD software now allows resource managers to quickly evaluate appropriate silvicultural options by "gaming" with the aid of a few mouse clicks. It is hoped that density management diagram literature will be dug out from the bottom of the filing cabinets, dusted-off, and used in the development sound silvicultural crop plans.

LITERATURE CITED

Archibald, D.J.; Bowling, C. 1995. Jack pine density management diagram for boreal Ontario. TM-005 (NWST TN-31). Ontario Ministry of Natural Resources, Northeast and Northwest Science and Technology. 20 p.

Drew, T.J.; Flewelling, J.W. 1979. Stand density management: an alternative approach and its application of Douglas-fir plantations. Forest Science. 25: 518-532.

Graph Summary Table

White Pine Planting, Thinning and Harvesting Plan

Site Index   19

	Current	Thinning 1	Thinning 2	Thinning 3
Total Age	30	30	53	103
Top Height (m)	13.5	13.5	18.5	23.0
Pre thin DBHq (cm)	7.7	7.7	14.1	21.9
Post thin DBH (cm)		9.0	16.1	25.4
Pre thin Density (stems/ha)	3658	3658	1599	873
Post thin Density (stems/ha)		1599	873	426
Trees Removed (stems/ha)		2059	725	447
Pre thin Basal Area (m2/ha)	17.0	17.0	25.0	33.0
Post thin Basal Area (m2/ha)		10.3	17.8	21.5
Basal Area Removed (m2/ha)		6.8	7.2	11.5
Percent Basal Area Removed		40	29	35
Pre thin Total Volume (m3/ha)	115	115	211	328
Post thin Total Volume (m3/ha)		71	154	218
Total Volume Removed (m3/ha)		44	57	110
Cum. Total Volume Removed		44	101	211

Print   Close

Figure 7.—*Summary Table.*

Farnden, C. 1996. Stand density management diagrams for lodgepole pine, white spruce and interior Douglas-fir. (Info. Report BC-X-360). Pacific Forestry Centre.

Langsaeter, A. 1941. Om tynning I enaldret gran-og furuskog, Medel. F.d. Norske Skogfoksvesen. 8: 131-216.

Smith, D.J.; Woods, M.E. 1997. Red pine and white pine density management diagrams for Ontario. SCSS Technical Report #48. Ontario Ministry of Natural Resources.

Woods, M.E.; Kaminski, D.; Pinto, F.; Kurtz, P. 1998. Ontario Density Management Diagrams – ODMD (Beta Version). Ontario Ministry of Natural Resources.

Yoda, K.; Kira, T.; Ogawa, H.; Hozumi, K. 1963. Self-thinning in overcrowded pure stands under cultivated and natural conditions. Journal of Biology. (Osaka City Univ., Japan) 14: 107-129.