Frontline

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"ONTWIGS" – A FOREST PROJECTION SYSTEM ADAPTED FOR ONTARIO

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CATEGORY: Decision support
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INTRODUCTION

ONTWIGS is a growth and yield stand projection system that was modified and adapted for Ontario from the LSTWIGS projection model. To achieve this, input/output metrification, conversion of species codes, and partial calibration of the model were required.

ONTWIGS can be used to evaluate the productivity and economic implications of various silvicultural prescriptions. It can also be useful when updating forest inventories, making silvicultural decisions, or making resource management decisions based on economic and silvicultural factors.

A session with ONTWIGS consists of setting simulation parameters, such as the number and length of rotations, the values for economic analysis, and the management prescriptions, and providing a list of the tree species represented in the stand to be projected. The tree list can be generated with a companion program, TREEGEN, or with a text editor.

ONTWIGS uses potential diameter growth and survival equations to simulate individual tree growth. Diameter growth is a function of the diameter at breast height (DBH) and live crown ratio of each sample tree, and site indices for each species group or for an entire stand. The survival equation calculates the probability of survival for each tree based on its current DBH and crown ratio.

The user can manage the stand by choosing from a variety of silvicultural techniques, such as thinning and harvesting options. After management, a real or comparative economic analysis can be made using one of several economic criteria. After each cycle of growth and management simulation, a stand report displays changes in productivity and volume.

Additional information about the program, including growth, survival, and other equations and their corresponding coefficients, can be found in Miner et al. (1987), Kowalski and Gertner 1989, Payandeh and Huynh (1991), and Payandeh and Papadopol (1994).

A users' guide and required software are available from the Canadian Forest Service–Sault Ste. Marie, Sault Ste. Marie, Ontario. (See the order form attached.)

SYSTEM REQUIREMENTS

The minimum required hardware for operating ONTWIGS includes:

- a personal computer, which is IBM AT or XT compatible (80x86 or 8088/8086 type processor);
- a graphics adapter and monitor that supports EGA, VGA, or SVGA graphics;
- 640k of installed memory;
- one 3.5-inch floppy drive; and
- DOS 2.0 or higher.

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THE DISTRIBUTION DISKETTE

The distribution diskette contains the following files:

TWIGS.EXE The ONTWIGS main executable file.

ONTWIGS.DAT, TEST.DAT The ONTWIGS data file containing the species-specific coefficients and the example data files used in the users' guide.

TREEGEN.EXE The executable program for formatting individual tree lists or for generating data files based on average stand data, if an actual individual tree list is not available for the stand.

ONTWIGS.BAT, RUNOPT.DEF, ECON.DEF Additional batch file and definition text files for running ONTWIGS.

RUNNING THE ONTWIGS PROGRAM

A flowchart of an ONTWIGS stand projection is provided in Figure 1. Before beginning, an input file that contains a list of trees representing the stand in question is prepared. This file can be generated with TREEGEN, or created using an editor.

ONTWIGS will set the projection parameters according to the run options, including the number and years in the projection interval, etc.

These options can be changed at the beginning or throughout execution of the program. Each option has a default value that is used until it is modified by the user. Once a run option is changed, the new value replaces the default value for subsequent ONTWIGS runs and sessions.

ONTWIGS CALIBRATION

As stated earlier, ONTWIGS is an adaptation of LSTWIGS for Ontario. LSTWIGS was developed and calibrated for Michigan, Wisconsin, and Minnesota. Without local calibration, the model may not accurately predict main stand attributes, such as survival, average diameter, and basal area per ha. Therefore, the model should be calibrated by modifying its coefficients, as described here, so as to reduce the prediction errors to acceptable levels (±5 percent). This simple, local calibration can be accomplished by separately adjusting the survival and potential diameter growth coefficients for each data set and/or species.

To understand the calibration process, equations for survival and potential diameter growth are presented together with the procedure describing how to modify their coefficients. The survival (S) and potential diameter growth (PG) functions are as follows:

$$S = b_1 - 1/(1+e^n)$$

where: S = tree annual survival

b's = species-specific regression coefficients

e = base of natural logarithm

$n = b_2 + b_3 DGR^{b4} + b_5 D^{b6} e^{-b7} D$

DGR = estimated annual tree diameter growth (cm)

D = current diameter

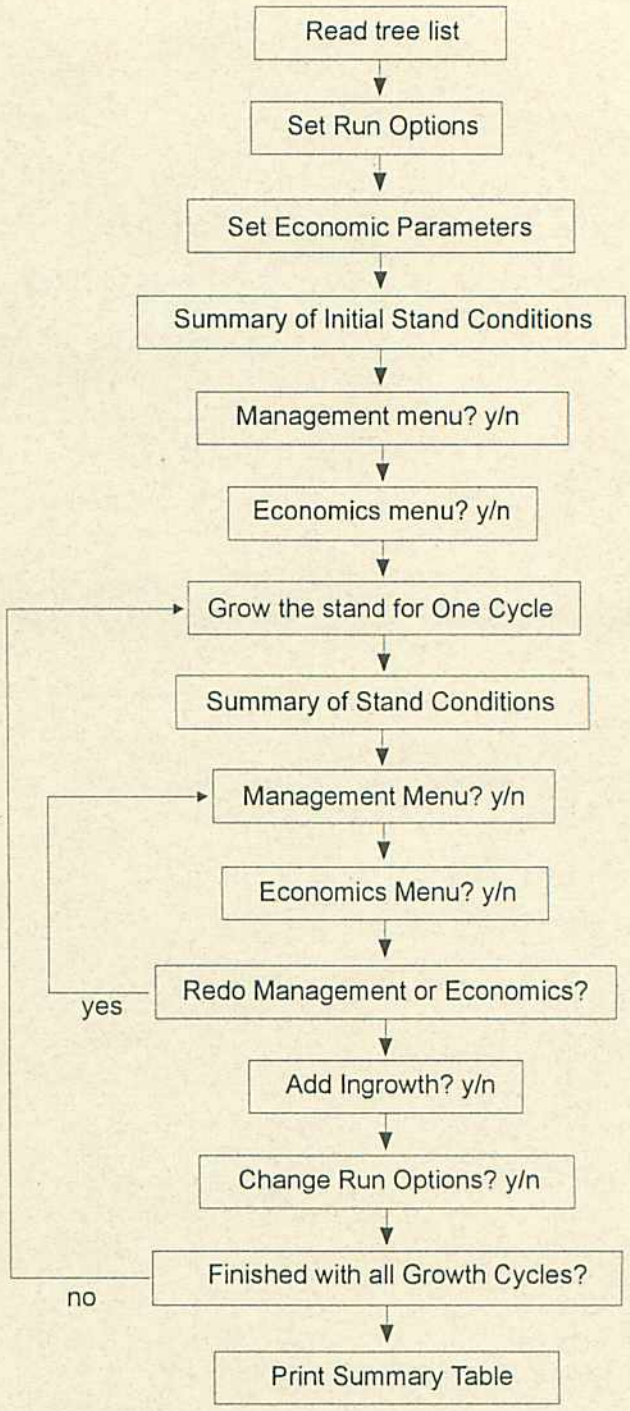

Figure 1. Flowchart of ONTWIGS projection.

$$PG = b_1 + b_2 D^{b3} + b_4 SI\ CR\ D^{b5}$$

where: PG = potential annual diameter growth (cm)

SI = site index (height [m] at base age 50 years)

CR = crown ratio code

The species-specific coefficients that are subject to change are located in the ONTWIGS.DAT file under *Potential growth* and *Survival coefficients*. The more important and sensitive ones are b_1 of *Potential growth* and b_1 and b_2 of *Tree survival*.

The steps involved in calibration include:

1. Run ONTWIGS with the tree list data.
2. Compare the projection against the actual data. Calculate the difference and the percent error for the main stand attributes (number of trees/ha [NTH], quadratic mean diameter [QMD], and basal area/ha [BAH]). If the percent errors exceed the allowable errors, the ONTWIGS.DAT file is edited and the coefficients b_1 for potential growth and b_1, b_2 for survival are modified.
3. Step 1 (run ONTWIGS) is repeated until the prediction errors meet the allowable error limit, say within ±5 percent.

Calibration for Boreal Mixedwoods

ONTWIGS was calibrated and validated for boreal mixedwood stands in north central Ontario based on permanent growth sample plot data from the James River/Marathon Paper Company limits. Stand density or number of trees/ha, quadratic mean diameter, and basal area were used as stand attributes of interest. Results indicated that the uncalibrated model (i.e., ONTWIGS with its original coefficients) produced 5-year prediction errors within ±10 percent for all stands examined. The average 5-year prediction errors were: -4.86, -0.10, and -5.01 percent for spruce (*Picea* spp.); -2.70, 0.32, and -2.31 percent for aspen (*Populus* spp.); -5.17, 0.10, and -5.07 percent for jack pine (*Pinus banksiana* [Lamb.]); and -4.90, 0.90, and -3.54 percent for balsam fir (*Abies balsamea* [L.] Mill.) cover types, and for NTH, QMD, and BAH, respectively. Local calibration of these stands was accomplished by adjusting tree survival and potential diameter growth coefficients so as to reduce the prediction errors to an acceptable level. Calibration resulted in average 5-year prediction errors falling well within ±5 percent for the three stand attributes and the four cover types examined. Validation of the calibration resulted in errors of similar magnitude. Therefore, it was concluded that with simple local calibration, ONTWIGS could be used for stand projection and inventory updates of boreal mixedwoods.

Calibration for Defoliated Spruce and Balsam Fir Stands

ONTWIGS was also calibrated for defoliated spruce–fir stands in northwestern Ontario.[1] Stand attributes used for calibration were quadratic mean diameter (QMD), number of trees/ha (NTH), and basal area/ha (BAH).

Local calibration was accomplished by adjusting tree survival and potential diameter growth coefficients. This resulted in prediction errors ranging from -51.9 to 103.3 percent, but with an overall average of only 9.1, -1.7, and 2.0 percent for the balsam fir cover type; from -42.2 to 77.2 percent, but with an overall average of only 3.3, -0.5, and 0.0 percent for the spruce cover type; from -66.0 to 64.6 percent, but with an overall average of -10.2, 12.4, and 4.9 percent for the aspen cover type; and from -60.0 to 1.3 percent, but with an overall average of -9.3, -0.8, and -9.5 percent for the black spruce cover type, for number of trees/ha, quadratic mean diameter, and basal area/ha, respectively. Results of this study indicate that ONTWIGS can be calibrated so as to predict, with an acceptable level of accuracy, major stand compositional changes due to spruce budworm attacks. Additional calibration of the model on larger data sets and other major insects or diseases of boreal mixedwoods may be warranted.

POTENTIAL FOR USE

The ONTWIGS model can be conveniently calibrated for use in different stand types and localities in Ontario. The procedure for such calibration and validation is fairly simple, and can usually be accomplished by adjusting the coefficients of the two submodels of survival and potential annual diameter growth. It may take up to three trials to bring the average 5-year prediction errors to an acceptable level.

It can be concluded that ONTWIGS is a flexible and useful stand growth and yield projection system for use in the boreal mixedwood of north central Ontario.

REFERENCES AND FURTHER READING

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❒ Yes, please send me the ONTWIGS software and Users' Guide for ONTWIGS on disk.

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