Field Note -- Forest Vegetation Simulator Ingrowth Tool: Incorporating ingrowth tree lists into FVS growth projections

By

Justin E. Arseneault[1,3]

Undergraduate Research Assistant

justin.a@unb.ca

Dr. John A. Kershaw, Jr., RPF, CF[1]

Professor of Forest Mensuration

kershaw@unb.ca

Dr. James B. McCarter[2]

Research Scientist

jmac@u.washington.edu

and

Dr. David A. MacLean[1]

Dean and Professor of Forest Management

macleand@unb.ca

[1]Faculty of Forestry and Environmental Management, University of New Brunswick, PO Box 44555, 28 Dineen Dr., Fredericton, NB E3C 1M7 Canada

[2]Rural Technology Initiative, College of Forest Resources, University of Washington, Box 352100, Seattle, WA 98195-2100

[3]Corresponding Author

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ABSTRACT -- The Forest Vegetation Simulator Ingrowth Tool (FVS_IT) was developed in the Python language and tested using the Northeast variant of FVS (FVS-NE). This tool incorporates specified ingrowth tree lists, stored in secondary tree list files, into FVS projections. It functions by retrieving information from a FVS keyword file, which is then modified to project data in a stepwise manner using user-defined time intervals. Between each time step in a simulation, FVS_IT incorporates ingrowth into projections by appending ingrowth tree records to projected tree lists and compiles a new tree list for the next time step. Outputs include both appended tree lists and stand summaries from FVS so that users can conduct further analyses. The FVS_IT application is useful when assessing and calibrating FVS using continuous forest inventory or permanent sample plots where periodic remeasurements include ingrowth trees.

Introduction

The Forest Vegetation Simulator (FVS) is the standard growth projection tool used by the US Forest Service and many other agencies (Dixon 2003). The US Forest Service has developed variants of FVS for all regions in the United States (Dixon 2003) and other organizations have developed similar variants for Canada (BC Ministry of Forests 2007; Ontario Forest Vegetation Simulator 2007). Graphical user interfaces, such as Suppose (Crookston 1997) and the Landscape Management System (McCarter et al. 1998) has made FVS the growth projection tool of choice for many forest managers.

This project evolved out of a larger regional project assessing the application of FVS-NE to the Maritime Provinces of eastern Canada. The initial phase focused on assessing and calibrating FVS-NE using the Nova Scotia Continuous Forest Inventory (CFI) database (NS Department of Natural Resources 2007). It was quickly discovered that incorporating ingrowth trees, observed in the periodic remeasurement data, into FVS was quite cumbersome and time consuming. Individual CFI plots had to be either projected for a single growth period and the tree list manually edited to incorporate ingrowth, or ingrowth had to be specified using the FVS NATURAL keyword resulting in plot-specific keyword files. The software described in this paper, the Forest Vegetation Simulator Ingrowth Tool (FVS_IT), was developed to automate the process of incorporating ingrowth trees into FVS simulations.

FVS_IT - An Ingrowth Tool for FVS

FVS_IT is a third-party application that works in conjunction with the Suppose interface, making stand projections a two-stage process (Figure 1). The first stage consists of using the Suppose graphical user interface (Dixon 2003) to generate a keyword file required by FVS during growth projection, and the second stage consists of using FVS_IT to modify the keyword file, incorporate ingrowth tree lists, and run FVS. To understand how FVS_IT operates, the behavior, inputs, and outputs of FVS and Suppose must be briefly explained (a complete description of these functions and formats are found in Dixon 2003).

The Suppose graphical user interface allows users to quickly set-up simulations, or modify existing ones, by providing links to menus of user-defined keywords that are subsequently used to generate a keyword file. The keyword file is a summary of all information entered into Suppose and used by FVS to project tree lists. The process of projecting tree lists with Suppose or FVS_IT only differs after users have generated a keyword file (Figure 1). Instead of continuing with stand projection within Suppose, users run FVS_IT, which reads and interprets a keyword file to obtain information including desired time scale, which tree lists to project, and where these tree lists are stored. FVS_IT generates a modified keyword file and runs FVS for one time interval. At the end of the projected time step, ingrowth trees are appended to the projected tree list and FVS is run again for another time interval. The process is repeated until all time steps are projected. As a result, FVS_IT runs consecutive 5-year projections instead of running a single projection in 5 year increments as is normally done when using FVS.

Projected tree lists from each simulated time step are read, processed, and reformatted to compile new tree lists that are used as input for the following projection. Ingrowth tree list files are stored with a format identical to tree list files required by FVS, with a four-digit year variable specifying when each record should be incorporated during FVS projections (Figure 2). Ingrowth files are then read between each simulation time step to identify and append ingrowth trees in to projected tree lists.

To run FVS_IT, users need to click on the program icon to start the program. Directory and File dialogs enable the user to select necessary keyword files, FVS variant, initial tree lists, and ingrowth tree lists. Once all inputs are entered, the **[Run Simulation]** button is clicked to launch the keyword file modification process and run FVS. FVS_IT only reads a given ingrowth file if its counterpart is present in the keyword file. If FVS_IT encounters a stand with no associated ingrowth file, it assumes there is no ingrowth for that stand and continues processing other stands. In order to easily and accurately associate ingrowth files with their respective stands, they

must be stored in the same location and bear similar filenames. Ingrowth tree lists have an additional "_ing" suffix. For example, if the stand #9 initial tree list is stored in "Stand9.fvs", the ingrowth data should be stored in "Stand9_ing.fvs". This naming convention, coupled with the restriction that files are located in the same directory allows FVS_IT to automatically locate any required ingrowth files. Once all projections are complete, FVS_IT compiles several space-delimited files containing tree list and stand summary output from FVS for further user-specific analyses. A copy of FVS_IT can be downloaded from: http://ifmlab.for.unb.ca/people/kershaw/.

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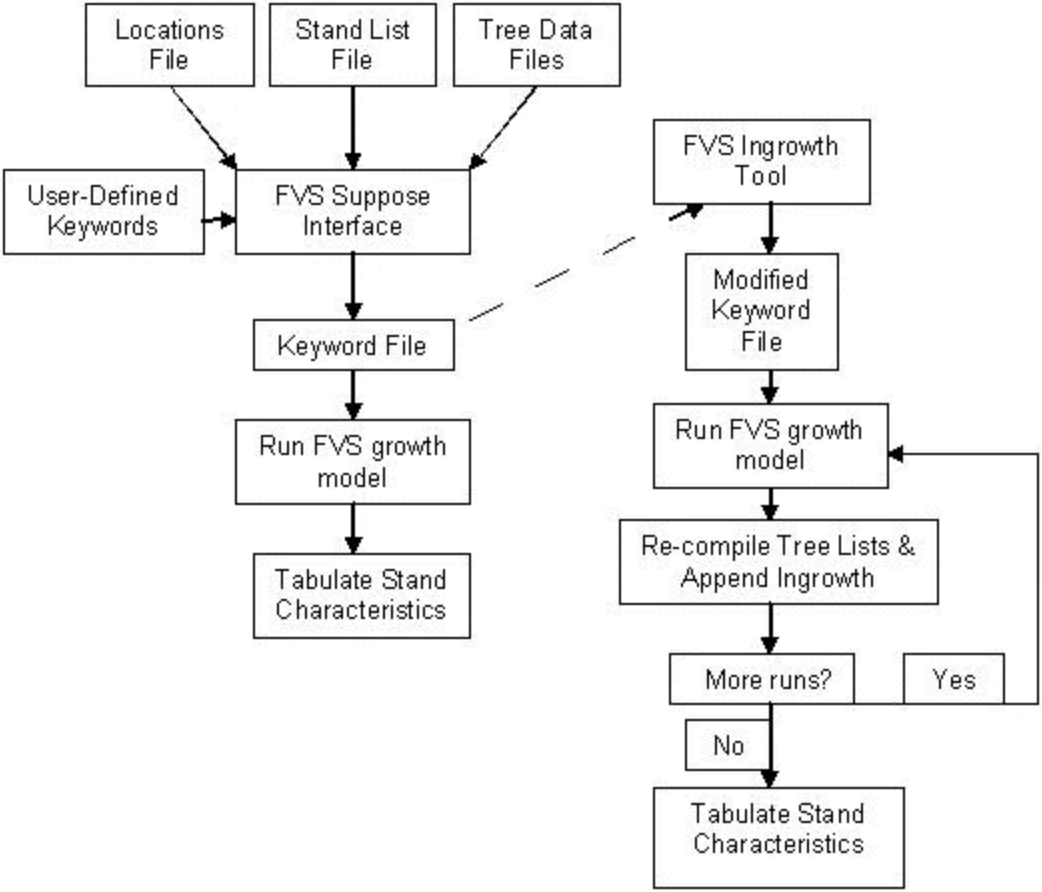
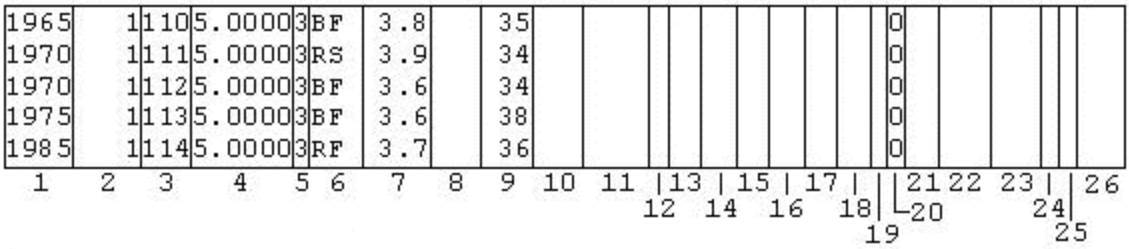
Figure 1. The process of projecting stands using the FVS Ingrowth Tool

Figure 2. Example ingrowth tree list file and explanation of record fields. For a complete description of fields, see Dixon (2003).


Locations File
Stand List File
Tree Data Files
User-Defined Keywords
FVS Suppose Interface
Keyword File
Run FVS growth model
Tabulate Stand Characteristics
FVS Ingrowth Tool
Modified Keyword File
Run FVS growth model
Re-compile Tree Lists & Append Ingrowth
More runs?
Yes
No
Tabulate Stand Characteristics



Field	Columns	Description
1	1 - 4	Year ingrowth record is appended to tree file
2	5 - 8	Plot ID
3	9 - 11	Tree ID
4	12 - 17	Tree count
5	18	Tree history
6	19 - 21	Species
7	22 - 25	Diameter at breast height
8	26 - 28	DBH increment
9	29 - 31	Live height
10	32 - 34	Height to top-kill
11	35 - 38	Height increment
12	39	Crown ratio code
13	40 - 41	Damage code
14	42 - 43	Severity code
15	44 - 45	Damage code
16	46 - 47	Severity code
17	48 - 49	Damage code
18	50 - 51	Severity code
19	52	Tree value class
20	53	Prescription code
21	54 - 55	Plot slope
22	56 - 58	Plot aspect
23	59 - 61	Plot habitat type
24	62	Plot topographic position
25	63	Plot site preparation
26	64 - 66	Tree age