Development of an Integrated Decision-support System for Jack Pine
Stand Density Management

Dear Project Member,

This Biannual Update highlights some of the activities which have recently occurred, or
are occurring, with regards to the CWFC R&D Project S0-4: Development of an
Integrated Decision-support System for Jack Pine Stand Density Management.

Since our 2008 Autumn meeting in Elk Lake, most of my effort has been directed at (1)
translating my 10000+ line Fortran algorithm to the VB.NET platform with the help of
Daniel Kaminski, (2) analyses of the Nelder plot data, and (3) developing and calibrating
individual model components such as the live crown and branch diameter isolines and
wood density prediction equations. Currently, the “alpha” version of the software has just
been completed and knowledge exchange sessions are being initiated. The translated
program retains the programming approach and algorithmic structure of the Fortran-
based software but of course is a Windows-based product, has better graphical output,
and is much more user friendly (e.g., see the last page of this document to view a screen
shot of the software’s graphical and tabular output). I am planning a series of face-to-face
meetings with team members (and interested colleagues) in the next few months to
actually enable a hands-on look at the software (I will get back to you on the specific
dates). Additionally, if you are planning to visit the GLFC, please let me know and I can
demonstrate the software for you. Once I have completed the debugging and completed
some preliminary validation checks on the resultant yield estimates, I will initiate the
beta-testing phase. After that, I will revise the software if needed and start to prepare for
an end-user workshop involving the broader forest management community in Ontario.

Although not fully confirmed due to budget unknowns regarding the 2009-2011 fiscal
years, I will be concentrating my efforts over the next 2 years as follows: (1) finalizing
the beta-version; (2) reporting/documenting the model structure and software;
(3) empirically testing the model's outputs (e.g., yield estimates) against new
remeasurement data from the Nelder plots (to be collected in-house this spring and
summer) and PSPs (from the Forest Co-op); and (4) initiating knowledge exchange and
tech-transfer activities. I will also be arguing for an expansion of the scope of the project
to include black spruce and merge a number of research projects into a larger one,
ettitled “Development of an Integrated Decision-support System for Density
Management in Boreal Stand-types”.

Concluding Notes

(1) I am planning to have a 3rd Annual Field Meeting this fall at the same venue as last
year but with an expanded group of interested colleagues and end-users. We will have the
opportunity to collectively review the status of the project and discuss its future direction,
in addition to viewing the utility of the beta-models in actual jack pine and black spruce
stand-types (Nelder Plots). I am tentatively planning a 2-day session in mid October 2009 for this;

(2) I will be preparing and submitting an amended project statement to the CWFC and will request funding for an additional 2 years (2009-2011), in the near future;

(3) There are still a number of research issues that could be addressed jointly and if you are interested, please let me know so that we can start on some sidebar studies (e.g., response delay issue, incorporating thinning effects into the diameter distribution recovery model, stand stability analysis; branch diameter – knot effects on grade and value estimates);

(4) In terms of current funding levels, currently all project funds have been exhausted with certainty of funding availability for the coming year(s) unknown at this time. Although I am hopeful that the CWFC will continue its support, any in-kind and fiscal support would be helpful in making a solid case. Given that the majority of the future software development and acquisition of field testing data is largely dependent on obtaining adequate funding, I would suggest that when the opportunity arises, please ensure that you convey your support for the project both within and outside of your organization. Normally, a project of this type should sell itself but as you know this is not always the case and thus please promote when applicable.

(5) To reiterate, the major indicator of success for this project will be measured by how much the forest management community actually uses the model (software) in planning and silvicultural decision-making. Consequently, demonstrating actual uptake within the OMNR and the broader Ontario forest management community, during the next 12-24 months, will be of critical importance.

Thank you again for your input and contributions and I look forward to meeting you in the next few months, and again in the fall. For more specifics, I have provided a “running tab” on the project activities to date; text highlighted in red denotes new material since my last update. If you require any additional information or clarification, please forward your requests.

Best Regards,

Peter

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Status and Update

(1) Composition of Project Team: Following an exhaustive assessment and discussions with key representatives throughout the Ontario forest sector, including science, senior policy, management, and tech-transfer staff from the OMNR and forest industry, the project team was enlarged via the inclusion of key members from the forest science, management, silviculture, policy, tech-transfer and end-user communities. This ensured scientific excellence, innovativeness and end-user uptake with a high likelihood of implementation in the forest management planning system of Ontario. Specifically, we now have 17 members: Dr. Peter Newton, Project Leader, CWFC (GLFC), CFS; Jeff Fera, CWFC (GLFC), CFS; Daniel Kaminski, Natural Logic Inc., North Bay, ON; Jeff Leach (Tembec Inc., Kapuskasing, ON); Ken Lennon (recently with Kimberly-Clark) Forest Productivity Specialist, Northeast Science and Technology, Ontario Ministry of Natural Resources (OMNR), South Porcupine, ON; Dr. Chuangmin Liu, Forintek, FPInnovations, Vancouver, BC; Scott McPherson, Forest Productivity Specialist, Southern Science and Information Section, OMNR, North Bay, ON; Glen Niznowski, OMNR (recently with Buchanan Forest Products Inc.), Soo Lookout, ON; John Parton, Growth and Yield Coordinator, Provincial Terrestrial Assessment Program, OMNR, South Porcupine, ON; Dr. Doug Reid, Research Scientist, Boreal Silviculture, Centre for Northern Forest Ecosystem Research, OMNR, Thunder Bay, ON; Dan Rouillard, Forest Modelling Specialist, Forest Management Branch, OMNR, Roberta Bondar Place, Sault Ste. Marie, ON; Dr. Mahadev Sharma, Forest Growth and Productivity Research Scientist, Ontario Forest Research Institute (OFRI), OMNR, Sault Ste. Marie, ON; Al Stinson, Forest Science Technical Leader, OMNR, North Bay, ON and Forest Research Operations Manager, Forestry Research Partnership, Canadian Ecology Centre, Mattawa, ON; Neil Stocker, Provincial Silviculturist, Boreal Forest – Forest Health and Silviculture Section, Forest Management Branch, OMNR, Roberta Bondar Place, Sault Ste. Marie, ON; Dr. Ung, Research Scientist, CWFC-Quebec; Dave Wood, Project Coordinator, Forest Ecosystem Science Co-operative Inc. Thunder Bay, ON; Dr. Tony Zhang, Senior Scientist and Group Leader, Forintek, FPInnovations, Vancouver, BC. Furthermore, we were able to acquire the assistance of a summer student (Jammin Pedalino) who assisted Jeff Fera in our 2008 field data acquisition program and a YMCA Intern (Melissa Bob) who helped us in the lab in compiling the Nelder plot data, which was kindly provided by John Parton.
(2) **Project Consultation:** Through a series of meetings and associated correspondence we have received excellent input from all project members. We have had a total of 4 small-to-medium sized meetings: (i) Meeting 1, August 2007 in Sault Ste. Marie dealing with project membership and initial steps (Doug Reid, Mahadev Sharma, Al Stinson, Murray Woods); (ii) Field Tour and Meeting 2 (see photo above), October 2007, in Timmins to review the status of the SDMD current models, discuss major new research components and their analytical solutions, discuss the objectives, scope and support levels for each of the project elements, and further define needs, roles and identify any outstanding gaps (Jeff Fera, Jeff Leach, John Parton, Mahadev Sharma, Al Stinson, Doug Reid); (iii) Meeting 3, November 2007 at OMNR Bondar Place - dealing with similar material as Meeting 2 but with silvicultural and modeling experts (Jeff Fera, Neil Stocker, Dan Rouillard); and (iv) Meeting 4, January 2008 in North Bay discussing the development of software with OMNR Natural Logic staff (Jeff Fera, Daniel Kaminski, Scott McPherson, Al Stinson, Murry Woods). I also received valuable input from those who were not able to attend the face-to-face meetings. The following is a partial list of some of the suggestions from you that are now part of the project: (i) testing the asymptotic size-density relationship for jack pine via density control experiments including the Nelder plot series; (ii) including an ingress and survival-based control function in the size-density trajectory models; (iii) functionally relating the models output in terms of yield estimates to other OMNR models (MIST; FVS; Patchworks); (iv) enabling the model to predict above-ground biomass by component (e.g., stem, branch and foliage); (v) maintain software consistency via engagement of Natural Logic; (vi) inhouse-quantification of additional wood quality attributes related to pulp quality and lumber strength; (vii) calibration and inclusion of isolines for knot-size and height-diameter ratios; and (viii) linking stand-level outputs to the forest level. Furthermore, in terms of knowledge exchange and tech-transfer, I presented overviews of SSDMDs with specific reference to our project, to forest management and scientific communities in 2008 via the Forestry Research Partnership’s Science Seminar Series held at the Canadian Ecology Centre (Mattawa), Great Lakes Forestry Centre (Sault Ste. Marie) and Le Centre de Loisirs (Kapuskasing). I also had the opportunity to demonstrate the utility of SSDMD via a field demonstration at the Kapuskasing meeting (see photo below).
In the Autumn we held our 2nd Annual Field Program Meeting in Elk Lake. Specifically, we (P. Newton; J. Fera; M. Sharma; N. Stocker; K. Lennon; S. Vasillauskas; A. Stinson; J. Parton; D. Reid; G. Niznowski) met at the Elk Lake Eco Centre from October 20-23, 2008 and reviewed the (i) status of the current model, (ii) major new research components and associated results, and (iii) future direction and additional project objectives. The Fortran algorithmic version of the model was presented and the comprehensive output distributed and discussed. We also visited the Nelder spacing plots north of Elk Lake to examine and contrast the long term effects on initial spacing in jack pine on individual tree attributes (individual tree size, stem taper, branching and crown development) and mortality patterns (e.g., comparing the current model’s predictions with regards to the asymptotic size-density relationship (self-thinning rule)). In addition to providing critical response and testing data, these plots are powerful tools in illustrating the effects of density management on individual tree attributes. As shown in photo below, the members are positioned between two jack pine spokes within the area of lowest density. The extreme branching and large live crown ratios are clearly evident. In terms of optimal tree size, taper, branch development and live crown ratio, 40 years post-establishment, the consensus from the group was that the 2 x 2 m spacing was the best overall (which is the 4th arc in). We also identify and discussed additional research opportunities with respect to this very unique and valuable plot series. Lastly, we had an excellent tour of Domtar’s state-of-the-art and highly efficient randomized length saw and planner mill in Elk Lake. Finally, the excellent weather and autumn colors combined with substantive discussions among members, resulted in interactive and fully engaged project team.

Furthermore, at the 2008 CWFC Forum in Quebec in November 2008, I presented a poster detailing the main components of the project to the CWFC employees. Overall, it was well received.

Lastly and of significant note was the Guy Smith’s use of the project’s structure and team approach in his CIF Electronic Lecture (February 2009) presentation on knowledge exchange. Specifically, Guy presented it as an excellent example to follow when attempting to develop and implement R&D products of operational significance within a forest management framework.
(3) Analytical Activities and Achievements

(i) The response delay analysis and integration of stand-type-specific taper equations for jack pine (Sharma and Newton); Status as of February 2008 - data has been collected and transferred to Mahadev for response analysis; and Mahadev has calibrated a composite jack pine taper function using the Sewell research plot data for use in the model. The taper models within the model structure enables the prediction of product assortments (e.g., number of pulp and saw logs and residual tip volumes). Further analysis is pending.

(ii) Development and integration of empirical models for predicting stability (Reid and Newton), branch diameter and wood density (Newton and Fera), and assess the need to incorporate additional fibre quality attributes possibly via in-house laboratory analysis/processing (Jeff Fera); Status as of February 2008 - data management and analysis activities ongoing; evaluations underway regarding the in-house processing of existing wood samples for additional fibre attributes via the WinDendro-based WinCell system. Note, part of the data currently being collected will be used in the development of the branch isolines. Based on historical data sets and some values derived from the literature, tentative composite prediction equations for live crown ratio, wood density and maximum branch isolines were developed and incorporated into the model and associated software. Composite equations for estimating biomass and associated carbon-equivalents for the above ground components were also developed and incorporated into the model.

(iii) Initiation of discussions with the external computer programmer in regards to extending the current shell used by the OMNR and possibly engaging his services (Newton); Status as of February 2008 – meetings and discussions were initiated and a 15-month contractual agreement was established with Natural Logic to develop of the software. Following input from most of the members, I am currently working with Daniel via frequent meetings and discussions to incorporate most of your suggestions in the new software program. Furthermore, I will soon be transferring the algorithmic sequence and associated computations and functional forms to Daniel for integration. Work is progressing well and hopefully I will be able to demonstrate a beta-version of the software at our fall meeting. Since our 2008 Autumn meeting in Elk Lake, most of my effort has been directed at translating my 10000+ line Fortran algorithm to the VB.NET platform with the help of Daniel Kaminski, preliminary analyses of the Nelder plot data, and developing and calibration individual model components such as the live crown and branch diameter isolines and wood density prediction equations. Currently, the “alpha” version has just been completed and knowledge exchange sessions are being initiated. I am also planning a series of face-to-face meetings with team members (and interested colleagues) in the next few months to actually enable a hands-on look at the software. Once I have completed the debugging and completed some preliminary validation checks on the resultant yield estimates, I will initiate the beta-testing phase. After that, I will revise the software if needed and start to prepare for a large end-user workshop involving the broader forest management community in Ontario. Of course all members our welcome to attend and hopefully assist me in delivering the workshop.

(iv) Testing the asymptotic size-density relationship in jack pine via the use of the existing Nelder plot data (Parton, Fera and Newton); Status as of February 2008 - data request to John Parton/OMNR was sent and data received. However, the quantity of the dataset is currently too small to proceed with the analysis. Consequently, discussions have been
initiated in order to determine the availability of additional Nelder plot data in Ontario. Hence upon field assessment (Spring 2008) and with assistance from John Parton, Stan Vasiliauskas and Ken Lennon, we implemented a field data acquisition program. Jeff Fera and our student were largely successful at remeasuring this plot series for the jack pine component with 22 of the 27 plots remeasured. Pending sufficient funding, I have designed a 2009 Field Data Acquisition Program in which we will return to the Nelder plots and complete the remaining jack pine measurements and initiate similar measurements on the black spruce component. The expectation is, that by the Autumn (2009), we will have sufficient data (Nelder and PSP measurements) to empirically evaluate the model’s predictions and develop additional isolines for live crown ratio and branch diameter for all 4 stand-types.

(v) Development of stand-type-specific product recovery and value functions which include stand-level variables (localization) employing existing data and expertise from Forintek (Zhang, Liu and Newton). Status as of June 2008 - the contractual agreement with FPInnovations (Forintek - Chuangmin Liu & Tony Zhang)) was completed. We are currently working together to report on the results of these analyses in addition to examining methods of incorporating branch metrics into the product value equations in order to account for the (large) product downgrade, which occurs due to knot size in jack pine lumber grading. Further analysis is pending.
Screen shot of the SSDMM for jack pine (as of March 1st, 2009); showing the dynamic SDMD with cursor output for natural stands, recovered diameter distributions, and summary table.