Western Boreal Growth and Yield Association

Annual Report 2013

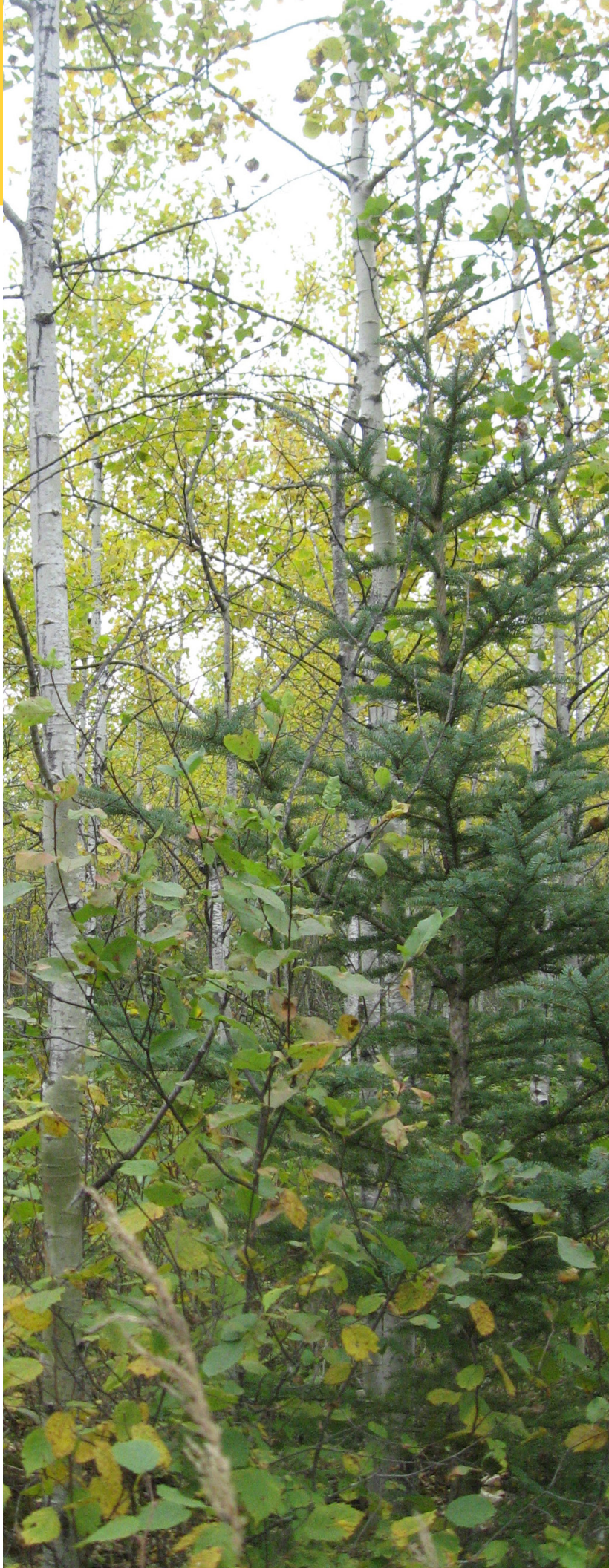
Forest growth, yield, inventory and planning in western Canada

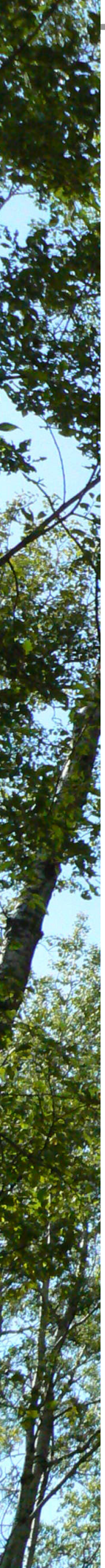
WESBOGY

www.WESBOGY.ualberta.ca

UNIVERSITY OF ALBERTA

CONTENTS





Executive Summary and Highlights

2012 marked the 28th annual fall meeting for the Western Boreal Growth and Yield Association and marked the 22nd year of measurement for the oldest of the WESBOGY Long-term study sites. Members of the association continue to collaborate on development and dissemination of growth and yield modeling technology and information for western boreal and montane forests. We work to support research, development and extension activities and support data sharing relating to growth and yield.

Current membership in the association includes seven forest companies, three provincial/territorial governments (Alberta, Saskatchewan and the Northwest Territories) and the federal government.

Work has continued on development of the Mixedwood Growth Model. A benchmark validation paper was published in the open access journal Forests and the website and documentation for MGM have been updated. Use of the model was demonstrated at the June 2012 Boreal Mixedwood Conference, cosponsored by WESBOGY, the U of A, the Canadian Wood Fibre Centre, Alberta ESRD, and the Alberta Mixedwood Management Accociation and at WESBOGY meetings.

10th year results from the Judy Creek Mixedwoods Study were collected in 2012 and show that radial spot treatments can improve spruce and aspen growth. Planned thinning treatments (unthinned, 2000, 1200 and 800 stems per hectare) were also implemented at Judy Creek in 2012.

In 2012 Kirk Johnson (M.Sc. student) completed field data collection for his study examining the effects of establishment practices on dynamics of white spruce plantation in Saskatchewan. We anticipate that Kirk will complete data analysis and his thesis in 2013.

Dan Jensen (M.Sc. student) and Mike Bokalo have made substantial progress on their study examining the use of LiDAR to measure gap area in stands and impacts of gaps on stand level yields. This study will also be completed in 2013.

Several other studies and initiatives are underway or under development that will contribute to a better understanding of effects of management practices on growth and yield of western boreal forests.

This Annual Report presents highlights of work accomplished during 2013 and outlines major activities planned for 2013.

April 2013

This past year has seen substantial progress relating to the Mixedwood Growth Model and other Western Boreal Growth and Yield Association activities. Our fall meeting in Swan River, Manitoba was outstanding. The meeting and field trip were informative and packed with interesting discussion. Special thanks to Paul LeBlanc and his team for the excellent arrangements.

After substantial work and several revisions, the benchmark validation paper for MGM was published in January 2013. Since completing this paper, substantial energy has been invested in obtaining approval for model use by Alberta and in providing support for model use. Providing support for model use and continuing with model development and refinement will remain an important priority for the next few years. Work on calibration of the model for jack pine in the western boreal is currently underway, with financial support from Saskatchewan Environment, ALPAC and Alberta ESRD.

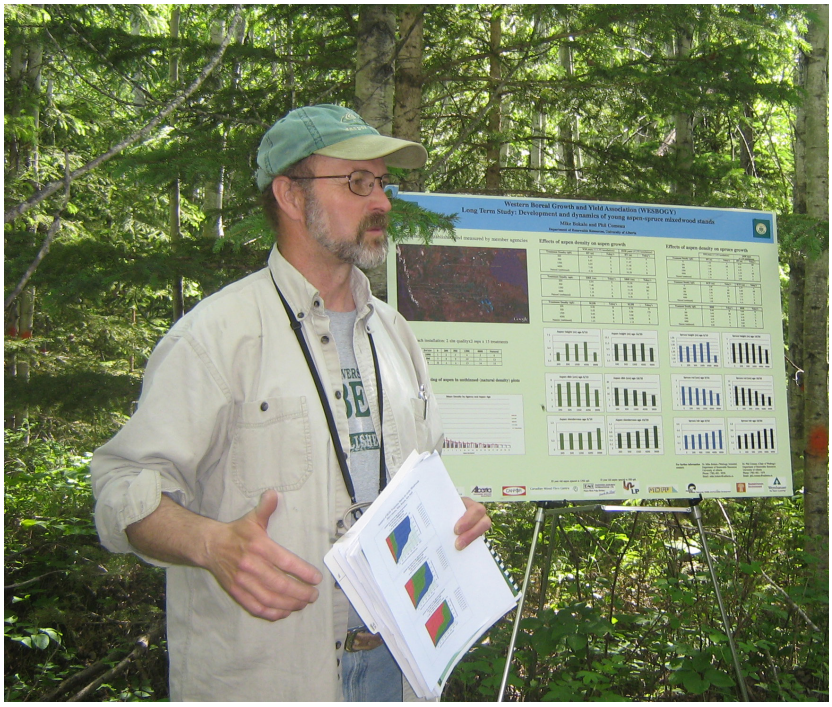
The Boreal Mixedwoods 2012 conference held in Edmonton in June was a great success, with over 110 people attending. The conference was jointly sponsored by Canadian Wood Fibre Centre, Alberta Environment and Sustainable Resource Development, WESBOGY, CIF-Forest Ecology Working Group, University of Alberta, and the Alberta Mixedwood Management Association.

We are making substantial progress relating to growth and yield applications of LiDAR and Wet Areas Mapping, with one field project nearly completed and two new projects getting underway in 2013. During the past year we have also been actively involved in discussions with the Foothills Growth and Yield Association, the Mixedwood Management Association, the Alberta Forest Growth Organization, and Tree Improvement Alberta regarding development of more formal linkages between these groups to improve on research and its delivery to end users.

During the next year we will also complete some major analyses of the WESBOGY Long-term Study data, and we will participate in the 16th International Boreal Forest Research Association Conference (being held in Edmonton in October). In addition, we will continue with internal discussions on topical growth and yield issues, development of new projects, and other activities.

Please contact me if you have any questions or ideas about WESBOGY projects and activities.

Phil Comeau
Chair, WESBOGY
Dept. of Renewable Resources
University of Alberta
751 General Services Bldg.
Edmonton, AB T6G 2H1
Email: phil.comeau@ualberta.ca



Mission Statement and Goals

The purpose of the WESBOGY Association is to conduct research projects that contribute to the development and dissemination of growth and yield information and modeling technology for both natural and regenerated stands growing in the boreal mixedwood region, primarily aspen and spruce.

Individual projects and/or students sponsored with Association resources should make progress in achieving this mission. Sponsored projects include those supported using Association resources. Associated projects are identified with the Association but are funded by individual (or groups of) Members or other sources. Business plans outlining project priorities and the allocation of resources to accomplish the mission are developed and periodically reviewed with the participation of Steering Committee Members.

GOALS

To develop and implement a program of research in the study of growth and yield and stand dynamics focused on problems of interest to Members of the Association. Projects will have defined goals and products, and will be completed in a timely manner.

To increase knowledge and awareness of growth and yield relationships, as they exist in western and northern Canada.

To foster communication, cooperation and exchange of information among the Members as well as various agencies and groups concerned with management and development of boreal forests.

To focus on the dynamics of mixedwood stands of aspen and white spruce growing in the boreal forest. Basic relations to be studied will include establishment, ingrowth, growth, and mortality. While the major species of interest are aspen and white spruce, other species such as balsam poplar, lodgepole pine, black spruce, and jack pine will also be studied. In developing simulation models based on these relations, provision will be made for projecting stands subject to multiple interventions (treatments) through the life of the stand. Differences between Natural Subregions (Ecoregions) and sites will also be evaluated where there is sufficient data.

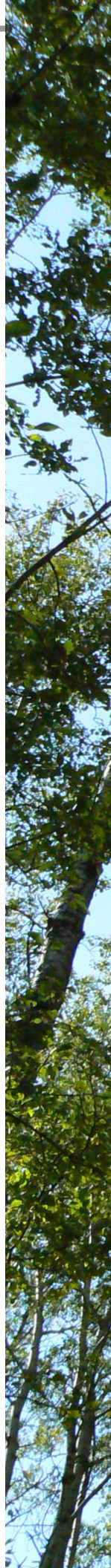
To encourage the establishment and continued monitoring of standardized permanent sample plots (PSPs) to quantify the effects of forest management practices in natural and regenerated stands, and in general to coordinate the acquisition of high priority growth and yield data;

To identify, evaluate, rank and address areas of research which are: of regional importance, of shared mutual interest, and most effectively approached cooperatively by the Association rather than by individual efforts;

To facilitate the dissemination of growth and yield data through the development of appropriate procedures, standards and databases for Members' use.

The following table lists measurable objectives identified for the 2011-2015 Agreement. It also includes links to the overall goals of the WESBOGY Association.

5 – year Objectives	Related Goals
1. To maintain the WESBOGY long-term study designed to evaluate the effect of spruce and aspen density levels on the development of plantations from establishment to final harvest. Maintain and update the database for the WESBOGY long-term study. Complete analysis of data. Encourage new Members to participate in the long-term study.	Goal #1 and #5
2. To develop and refine growth and mortality relationships and incorporate these new relationships into the MGM growth simulator.	Goal #1 and #2
3. To expand the scope of the MGM growth simulator as a tool for the development of managed stand yield projections for the major commercial tree species in the region. This will also include providing support for studies required to develop models of tree and stand response to establishment, tending and harvesting practices.	Goal #4, #5, and #6
4. To maintain a website that will identify, evaluate and disseminate information on trends in growth and yield research	Goal #3 and #7
5. To hold annual technical meetings for dissemination of information obtained from ongoing Sponsored Research Projects as well as other speakers invited to address other relevant growth and yield issues	Goal #3 and #7
6. To expand the scope of WESBOGY activities by recruiting new Members and seeking opportunities to augment the research component by securing funding from other granting agencies.	Goal #1, #2, #3 and #6
7. To identify and summarize regional PSP database standards and protocols for data exchange and use with regional growth models.	Goal #2, #3, #5 and #7
8. To collaborate with other agencies and organizations in the development of research and acquisition of data to support a better understanding of and development of models to estimate effects of silviculture on yield.	Goal #1, #2, #3 and #4
9. To identify and prioritize research needs and to initiate new projects as appropriate under the direction of the Steering Committee and Members.	Goal #1, #2 and #6

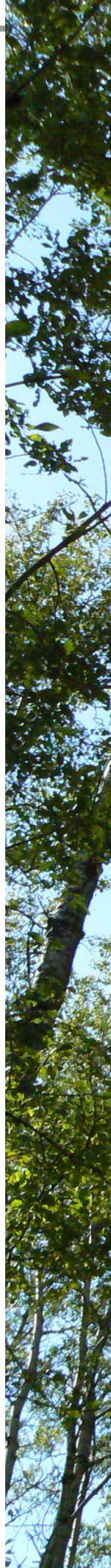


5-Year Program (2011-2015)

1. To continue analysis of the WESBOGY long-term study including:
   - Height, diameter, and density patterns for aspen in the natural plots;
   - Height and diameter growth of spruce and aspen in treated plots;
   - Mortality of spruce and aspen;
   - Recruitment (ingress) of new trees into natural and treated plots;
   - Preparation of manuals, reports, papers, extension notes and posters for distribution to Members and for journal publication;
2. To continue development of MGM to improve its ability to represent stand responses to silviculture. This will include:
   - Refinement of mortality, breakup and self-thinning functions for aspen;
   - Evaluation of model sensitivity to site index;
   - Natural regeneration and ingress of white spruce and aspen;
   - Refine calibration for lodgepole pine;
   - Calibrate MGM for black spruce, jack pine and balsam poplar;
   - Model Validation and publication of results;
   - Demonstration and training.
3. To update and maintain the WESBOGY long-term study data collection manual, the database, and the WESBOGY website and sharepoint site.
4. To seek to expand the scope of WESBOGY activities and influence.
   - To identify and approach potential new Members;
   - To seek opportunities and develop proposals for potential complementary funding from other agencies.
   - To work with other groups and co-operatives and to promote WESBOGY activities and information in growth modeling, silviculture practices and forest management activities.
5. To organize the WESBOGY Fall, Spring, and Steering Committee meetings each year. Prepare the meeting minutes and WESBOGY annual reports.
6. To review and update the list of priority and ongoing projects.
7. To undertake high priority Sponsored Research Projects as recommended by the Steering Committee and approved by the Members.
8. To work with Members in the development of proposals for high priority associated research projects.

Current Research Projects

WESBOGY Long Term Study	
Maintenance of Long Term Study Data	**Status:** Long Term - Ongoing **Researchers:** Mike Bokalo, Phil Comeau, Susan Humphries
Analysis of Long Term Study Data	**Status**: Analysis of data received through 2012 completed for all installations over 10 years old and summarized in Annual Report. Analysis of all data planned for early 2014. **Researchers**: Mike Bokalo, Phil Comeau, Susan Humphries
Siphon Creek and Bear Mountain	**Status**: These two studies examining effects of aspen density manipulations on spruce and aspen growth were established by the BC Ministry of Forests, Lands and Natural Resource Operations in 1990. Data were recently collected (2011), stored in the LTS database and are being analyzed (2013-2014). Publication of results in a journal article is planned. **Researchers**: Richard Kabzems Mike Bokalo, Phil Comeau, Dan MacIsaac and Susan Humphries
MGM Development	
Validation of MGM2010A	**Status**: Manuscript Published January 2013 **Researchers**: Mike Bokalo, Ken Stadt, Phil Comeau, and Steve Titus
MGM Height, Diameter and Mortality Functions for jack pine	**Status**: Initiated in late 2012 with funding from Saskatchewan Environment. Funding by Alberta ESRD and ALPAC received in 2013. **Researchers**: Mike Bokalo and Phil Comeau
Conversion of MGM to Visual Basic Stand Alone	**Status**: Initiated in 2012 and currently underway. **Researchers**: Mike Bokalo and Steve Titus
Associated Research Projects	
Effects of herbaceous and woody vegetation control on early boreal mixedwood stand development (Judy Creek Mixedwood Regeneration study)	**Status**: Study initiated in 2002; paper published in 2010 in CJFR (6th year results); 10th year remeasurement completed in 2012; thinning treatments completed in August 2012. **Researchers**: Doug Pitt, Phil Comeau, Dan MacIsaac, Milo Mihajlovich and Michael Hoepting
Stand Density Index and its relationships with productivity and understory vegetation	**Status**: Initiated in 2007; one paper published in 2012; PhD thesis to be completed in 2013. **Researchers**: Valentin Reyes-Hernandes (PhD student) and Phil Comeau
Influence of silviculture on the successional dynamics of mixedwood stands	**Status**: Initiated in 2011 with funding from Saskatchewan Environment. Data analysis and thesis preparation is underway with completion expected in 2013. **Researchers**: Kirk Johnson (M.Sc. student), Phil Comeau and Mike Bokalo
The use of LiDAR and Wet Areas Mapping in representing Stand Structure and Unproductive Gaps in Forest Stands	**Status**: Initiated in 2011; field work completed in 2012 and 2013. Data analysis and thesis preparation underway. **Researchers**: Dan Jensen (M.Sc. student), Mike Bokalo, Phil Comeau and Barry White
Benchmarking Natural (fire origin) stand regeneration	**Status**: Manuscript Submitted to Journal of Vegetation Science **Researchers**: Stefanie Gaertner, Mike Bokalo, Ken Stadt and Ellen Macdonald
High precision prediction of site index and future yield by use of wet areas mapping and full feature LiDAR	**Status**: Initiated in 2012; data acquired 2012 and 2013; field data collection to be completed during 2013. **Researchers**: Gabriel Oltean (M.Sc. student), Phil Comeau, Mike Bokalo, and Barry White
Prediction of future forest productivity and silvicultural challenges using Full Feature LiDAR, Wet Areas Mapping and Landform: A case study using the 1968 Marten Hills Fire	**Status**: Being initiated in 2013. **Researchers**: Ivan Bjelanovic (M.Sc. student), Phil Comeau, Mike Bokalo, John Nash and Barry White



Agency/Company	Current Membership
Alberta Sustainable Resource Development	Since 1985
Alberta-Pacific Forest Industries Inc.	Since 1990
Alberta Plywood	Since 1985
British Columbia Ministry of Forests	1985-2003
Canadian Forest Products	Since 1985
Daishowa-Marubeni International Ltd.	Since 1990
Wood Fibre Centre, Canadian Forest Service	Since 2009
Louisiana-Pacific Canada Ltd., British Columbia	Since 1997
Louisiana-Pacific Canada Ltd., Manitoba	Since 1996
Manning Diversified Forest Producs Ltd.	Since 1997
Northwest Territories Resources, Wildlife and Economic Development	Since 1985
Saskatchewan Ministry of Environment	Since 1985
University of Alberta	Since 1985
Weyerhaeuser Company, Alberta Forestlands	Since 1985

Steering Committee Members

A Steering Committee, consisting of three or four members elected to the Committee at the Annual Fall meeting, and the Chair and the Research Scientist sets policy, develops strategic objectives and priorities, reviews work plans, adjusts annual membership assessments in light of planned activities, and deals with other items which may arise.

2000 Titus, Wang, Behuniak, Niemi, Weeks
2001 Titus, Behuniak, Niemi, Nichol, Ewan
2002 Titus, Bokalo, Comeau, Behuniak, Niemi, Nichol, Ewan
2003 Comeau, Bokalo, Titus, Behuniak, Niemi, Nichol, Ewan/Ashley
2004 Comeau, Bokalo, Titus, Behuniak, Nichol, Ashley, Whittaker
2005 Comeau, Bokalo, Titus, Behuniak, Nichol, Ashley, Whittaker
2006 Comeau, Bokalo, Behuniak, Nichol, Blue/Ashley, Whittaker/Whitmore
2007 Comeau, Bokalo, Nichol, Ashley, Whitmore, Morgan
2008 Comeau, Bokalo, Leblanc, Zaichkowsky, Whitmore, Morgan
2009 Comeau, Bokalo, Leblanc, Whitmore, Morgan
2010 Comeau, Bokalo, Leblanc, Whitmore, Morgan, Blue
2011 Comeau, Bokalo, Leblanc, Whitmore, Morgan, Blue
2012 Comeau, Bokalo, Leblanc, Whitmore, Blue

Long Term Study of Aspen/Spruce Stand Development

Mike Bokalo, Phil Comeau and Susan Humphries

The WESBOGY Long Term Study is designed to advance our understanding of the dynamics of mixedwood stands following tending. The study, initiated in 1990, involved planting white spruce seedlings in recently clearcut areas where aspen regeneration had already been established. For the first 5 years, vegetation was controlled by clipping or using plastic mulch mats within a 40 to 50 cm radius of the spruce to minimize early spruce mortality. After a 5 year establishment phase, both the spruce and aspen were thinned to desired treatment densities.

The objective of the thinning was to achieve desired densities but retain potential crop trees at relatively uniform spacing. The study uses a randomized block design with each agency setting up and maintaining one block of two installations; one installation on a superior site and one on a median site. Each installation consists of two replications of 15 plots representing the different combinations of spruce and aspen treatment densities. Today, the study includes a total of 615 plots in Alberta, British Columbia, Manitoba, Saskatchewan and the Northwest Territories.

Data collection, database management and maintenance work continued in 2012. A new revised data collection manual was released in 2012 to deal with plot expansion and a new photo protocol that required photos to be taken from key plot locations.

Publications from the WESBOGY LTS

Bokalo, M., P.G. Comeau and S. J. Titus. 2007. Early development of tended mixtures of aspen and spruce in western Canadian boreal forests. For. Ecol. Manage. 242, 175-184.

Cortini, F., P.G. Comeau and M. Bokalo. 2012. Trembling aspen competition and climate effects on white spruce growth in boreal mixtures of Western Canada. Forest Ecology and Management 277:67–73.

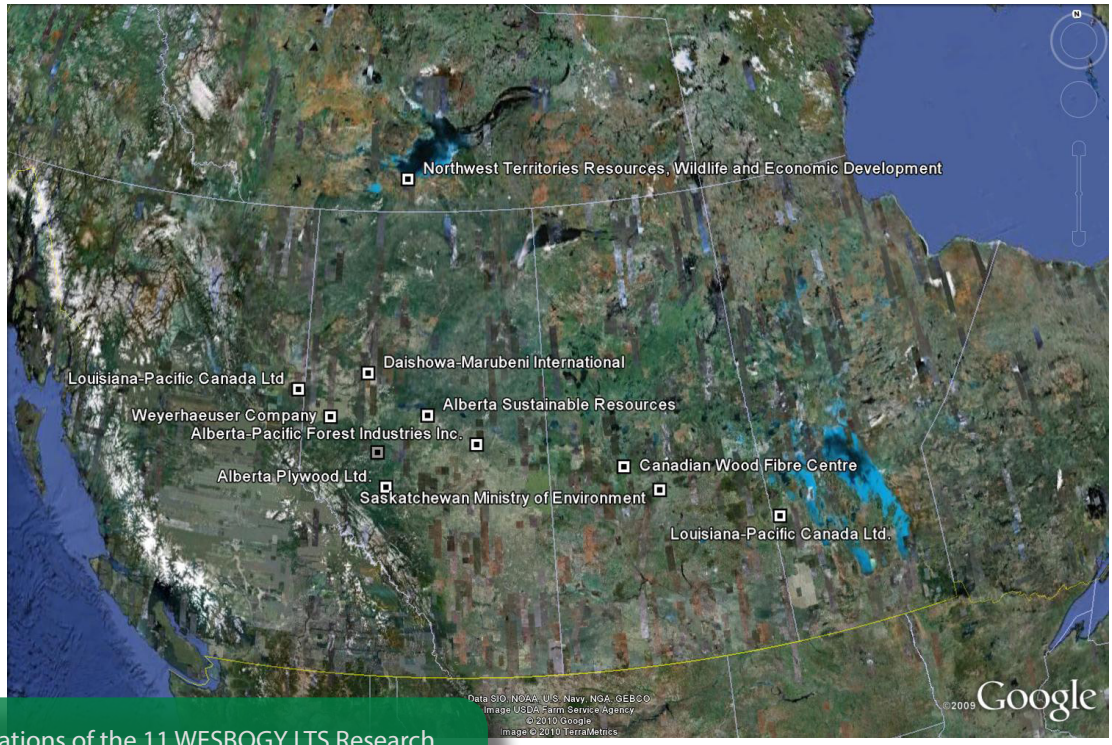
Filipescu, C.N. and P.G. Comeau. 2007. Aspen competition affects light and white spruce growth across several boreal sites in western Canada. Can. J. For. Res. 37: 1701-1713.

Filipescu, C. and P. Comeau. 2011. Influence of Populus tremuloides density on air and soil temperature. Scand. J. For. Res. 26:5, 421-428.

Voicu, M. and P.G. Comeau. 2006. Microclimatic and spruce growth gradients adjacent to young aspen stands. Forest Ecol. Manage. 221: 13-26

History and Locations of Long Term Study Installations

Company or Agency	Agency Code	Site	Year Spruce Established	Measurements Including 2012
Alberta Sustainable Resource Development	SRD	Med	1992	20
Alberta-Pacific Forest Industries Inc.	ALP	High Med	1994 2001	19 11
Canadian Forest Products Ltd.	CFR	High Med	2000 2001	12 11
Daishowa-Marubeni International Ltd.	DMI	High Med	1992 1992	20 20
Louisiana-Pacific Canada Ltd., Manitoba	LPSR	High Med	1998 1998	14 14
Louisiana-Pacific Canada Ltd., Dawson Creek	LPDC	High Med	2001 2004	11 9
Northwest Territories Resources, Wildlife and Economic Development	NWT	High Med	1993 1993	19 19
Alberta Plywood	WFR	High Med	1992 1993	18 18
Weyerhaeuser Company, Alberta Forestlands	WGP	High Med	1991 1991	21 21
Saskatchewan Ministry of Environment	SSK	High Med	1990 1990	22 22
Wood Fibre Centre, Canadian Forest Service	CFS	High Med	1992 1992	20 20



Locations of the 11 WESBOGY LTS Research Installations

MGM Development

Mike Bokalo, Phil Comeau and Steve Titus

MGM validation

The manuscript "The Validation of the Mixedwood Growth Model (MGM) for Use in Forest Management Decision Making" *Mike Bokalo, Kenneth J. Stadt, Philip G. Comeau and Stephen J. Titus*, Forests 2013, 4, 1-27; doi:10.3390/f4010001 was published in January of 2013. The validation compared model predictions against stand level data (average height, top height, DBH, volume, basal area and density) and stand level growth, using 4 permanent sample plot databases; the ASRD mature PSPs and juvenile stand dynamics system plots (SDS), the juvenile WESBOGY LTS plots and the mature Saskatchewan PSPs. Residual plots and statistical tests (average mean bias, relative model bias, efficiency and equivalence testing) were used in the validation and show that the model validates well for both juvenile and mature stages of stand development for both pure and mixed species stands of aspen and spruce. A subsequent validation using mature ASRD lodgepole pine and juvenile SDS lodgepole pine plots shows that the model validates well for lodgepole pine as well.

Model approval for use in management planning in Alberta

An important requirement in obtaining approval from ASRD for the use of MGM in management planning in Alberta was met with the publication of the validation results. On February 12th a formal letter was sent to ASRD requesting that MGM be approved for use in management planning in Alberta. The formal request was acknowledged and a formal review by ASRD was initiated.

MGM Software Development

The movement of MGM from a research tool to a forest management planning tool required that MGM be migrated to a professional software development platform such as Visual Studio. This would allow the better integration of MGM with Excel, Visual Basic and C++ code. Under the new platform, MGM will be a compiled program which will be more portable, run faster and allow for better integration with other programs. A Beta test version is expected for late 2013.

MGM Documentation and Website

The MGM documentation and model structure was updated and enhanced in order to meet regulatory requirement of full model disclosure. The MGM Website (MGM.ualberta.ca) offers a publicly accessable portal for downloading MGM.

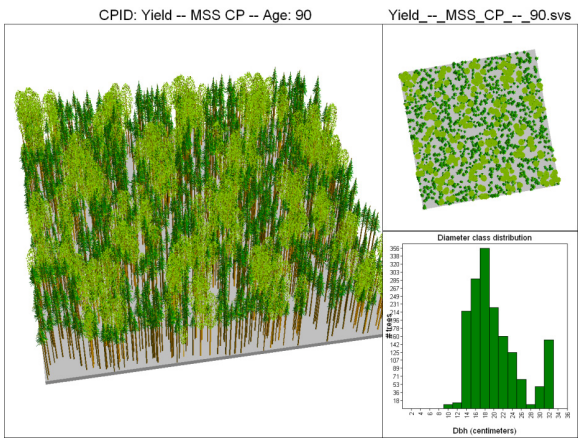
MGM Jack Pine Calibration

In 2012, a cooperative project funded by the Saskatchewan Environment, Alberta Pacific Forest Industries and the Alberta Environment and Sustainable Resource Development was intitiated. The objective was to develop MGM height and diameter increment relationships, and mortality functions for Jack pine using existing Saskatchewan, Alberta and Manitoba PSP data and to use these in parameterizing MGM for jack pine.

Application of MGM

There has been continued development and demonstration of MGM's capabilities to model different tending/treatments scenarios. Presentations at the Boreal Mixedwoods conference successfully demonstrated the use of MGM.

Pulse Spray Study



MGM MSS Simulation of Pulse Spray

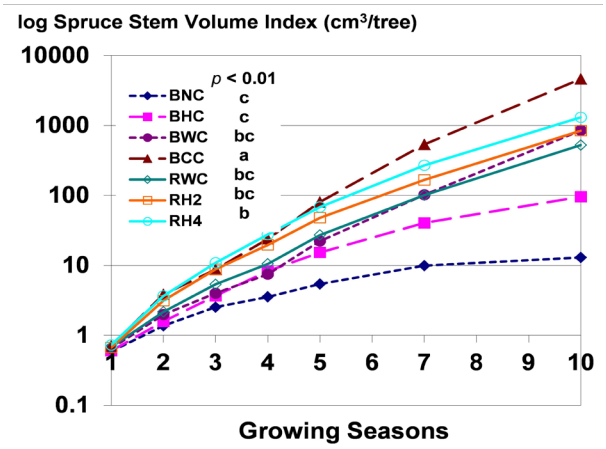
Effects of Herbaceous and Woody Vegetation Control on Early Boreal Mixedwood Stand Development (The Judy Creek Mixedwood Study)

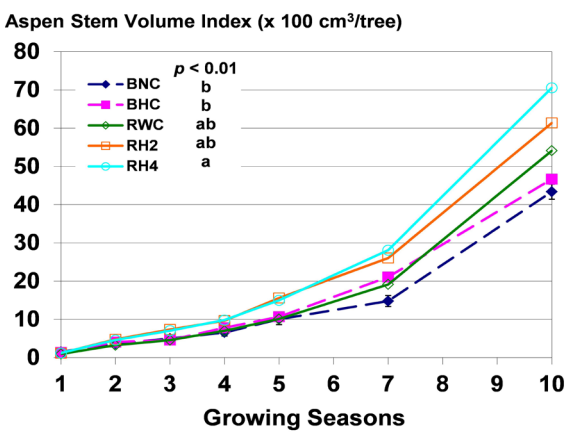
Doug Pitt, Phil Comeau, Dan MacIsaac, Milo Mihajlovich,Michael Hoepting and Susan Humphries

In 2002 we initiated this study at Judy Creek to examine effects of planting spruce at 5-m spacing, tending them individually with 2-m radial treatments, and leaving aspen to regenerate naturally in the intervening area between the spruce. We also compared the effects of controlling only the woody component against control of both woody and herbaceous vegetation for 2 and 4 years after planting. The site is located 30 km northeast of Whitecourt Alberta Canada (54°03' N, 115°36'W; elevation: 1000 m).

At age 10 (2012) the best growth of spruce was observed in the broadcast complete control treatment while the poorest growth is evident in the untreated and broadcast herbaceous control treatments due to low light levels and substantial browsing by snowshoe hare. Intermediate spruce growth responses were obtained with early woody control, or woody and herbaceous control, in both the radial and broadcast applications. However, radial treatments provided marginally larger trees than those in the broadcast woody control treatments (5 – 26). Spruce receiving either 2 or 4 years of early herbaceous and woody control were 23 – 56% larger than spruce that only received woody control. The radial treatments have resulted in improved spruce production on an individual tree basis, compared to broadcast woody-only control, and is further improved when combined with at least two years of early herbaceous competition control. The benefit of four years of early herbaceous control, rather than two years, is still being realized with a 55% gain in stem volume.

Aspen height is unaffected by the treatments, but diameters and stem volumes of the 16 selected crop trees in each plot were generally largest in radial control treatment plots (5 – 15% gain), especially those that received herbaceous control (12 – 37% gain).





In August 2012 aspen thinning treatments were applied to fifteen selected radial treatment plots (Table 1). With the constraint of maintaining uniform density across the plots, aspen crop trees were selected as the "best" in terms of health, stem form, and size, approximately in that order. Crop trees were selected by the project team (marked with flagging tape) prior to thinning. Care was taken to avoid damaging planted spruce, and slash was aligned with the planted rows. We expect that the light and competitive conditions created by the resultant four aspen densities will differentially influence the future growth of the planted spruce.

Table 1. Pre-commercial thinning treatments applied to radial control treatment plots

	Target Aspen Density (stems per hectare)			
	800	1200	2000	unthinned
Woody Control (RWC)	3 plots	1 plot	1 plot	3 plots
2 years Herbaceous Control (RH2)	1 plot	3 plots	1 plot	2 plots
4 years Herbaceous Control (RH4)	3 plots	1 plot	1 plot	3 plots

Assessing site preparation effects and modelling long-term growth in Saskatchewan white spruce plantations

Kirk Johnson, Phil Comeau and Mike Bokalo

Management practices applied during early stand development can strongly influence long-term growth, composition, and yield. Given the important role of juvenile growth, sustainable forest management requires accurate predictions of early stand development to support social, ecological, and economic objectives. In 2011 and 2012, 16 white spruce (Picea glauca) plantations (13-18 years old) and 18 "managed-stand" white spruce PSPs (20-29 years old) were sampled in Saskatchewan to assess juvenile growth and evaluate early-successional modeling performance under the Mixedwood Growth Model (MGM).

Juvenile growth and stand dynamics have been examined using repeated measures from the managed-stand PSP dataset from Saskatchewan (e.g. Figure 1). MGM modeled-growth has been compared to observed PSP growth, in juvenile white spruce stands. Ongoing work will use MGM to forecast long-term (80 to 120 years) impacts of establishment practices, consider provincial regeneration surveys as a data source for MGM initialization, and investigate site preparation/tending effects across four treatments: disc trenching, bracke mounding, and v-blade scarification, and disc trenching + thinning.

Preliminary results stress the importance of site-specific responses to tending and site preparation (Figure 1). Furthermore, observed white spruce growth on juvenile managed-stand PSPs exhibits considerably more variation than MGM-modeled white spruce growth, suggesting herbivory, climate (e.g. frost damage), and/or mechanical damage (e.g. leader whip, snow breakage) strongly influence growth outcomes. Finally, "ideal" MGM site index assumptions should be derived from pre-harvest data (where possible) or trusted alternative sources (e.g. ecosite guides). We anticipate completion of this project in the Fall of 2013. Funding for this project is being provided by Saskatchewan Environment.

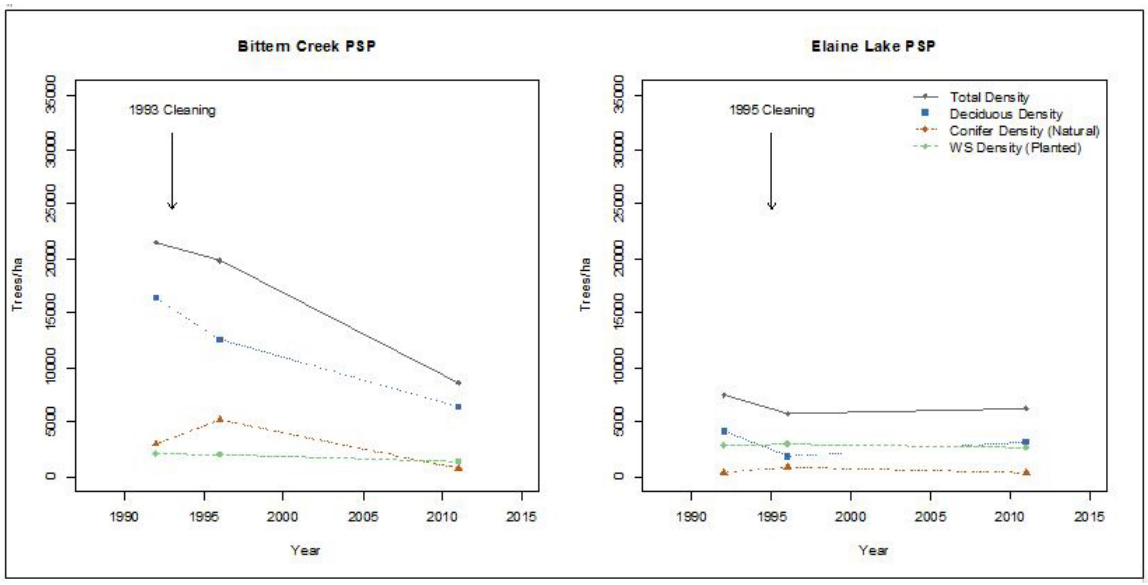


Figure 1. Long-term plot density for the Bittern Creek and Elaine Lake PSPs. Both PSPs were established on submesic sites in 1989 via disc trenching. Point features represent plot measurements in 1992, 1996, and 2011. Arrows denote cleaning events. In this example, the Bittern Creek PSP experienced continued deciduous self-thinning after a 1993 cleaning while the Elaine Lake PSP experienced a slight increase in deciduous density after a 1995 cleaning. Planted white spruce density remained relatively stable across both PSPs.

The use of LiDAR and Wet Areas Mapping (WAM) in representing Stand Structure and Unproductive Gaps in Forest Stands

Dan Jensen, Mike Bokalo, Phil Comeau and Barry White

Albeta Vegertation Inventory (AVI) polygons are often considered homogeneous and consistent with the biological definition of a stand, but in reality they are heterogeneous entities formed from many differently stocked sub-stands that on average represent the AVI forest stand structure. This project has developed a method of using LiDAR and Wet Areas Mapping (WAM) to quantitatively estimate the percent area in gaps in a sample of stands in Alberta. Figure 1 shows an aerial photograph of stand 289 with the AVI polygon boundary as well as interpreted 10% canopy cover class boundaries. Figure 2 shows the unmerchantable gaps (dark brown) detected using a 2 meter LiDAR raster. Of the total stand area (25.3 ha), approximately 4.8 hectares (19%) are in LiDAR gaps larger than 10m2. The LiDAR gaps however do not represent the true growing space available since the amount of crown encroachment into the open area is unknown. For every LiDAR gap the expanded gap represents the area from stem to stem obtained from field measurements. The expanded gap is a stable representation of the true growing space available by eliminating the crown encroachment effect (light green area; Figure 3). From a sample of LiDAR gaps within polygon 289, a strong relationship between LiDAR gap size and the expanded gap size can be seen (Figure 4). The slope of the linear regression line suggests that expanded gaps are 1.86 times larger than the LiDAR gap (R2 = .8773). The next phase of this research is to quantify the potential yield loss due to the presence of these gaps. Additionally, the detection and presence of natural gaps are thought to be strongly influenced by the depth to water. Figure 5 shows the WAM image for stand 289. The correlation between gaps and wet areas is clearly visible. Understanding the relationship between gaps and wet areas is now under investigation.

This study shows that the current resolution of LiDAR (1.68 hits/m2) is sufficient to identify and estimate the percent area within a stand that is contained in unproductive or unmerchantable gaps. It is believed that WAM will identify whether these gaps are related to topography and seasonal flooding. The application of these estimates will be used to operationally adjust estimated yield into ranges that are indicative of the landscape level yields found in natural stands an essential requirement for sustainable forest management. This project is Funded by Alberta Sustainable Resource Development.

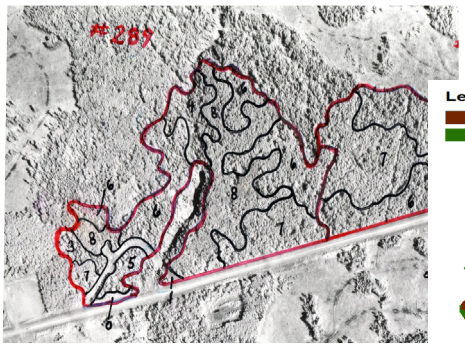


Figure 1.

Figure 2.

Figure 3.

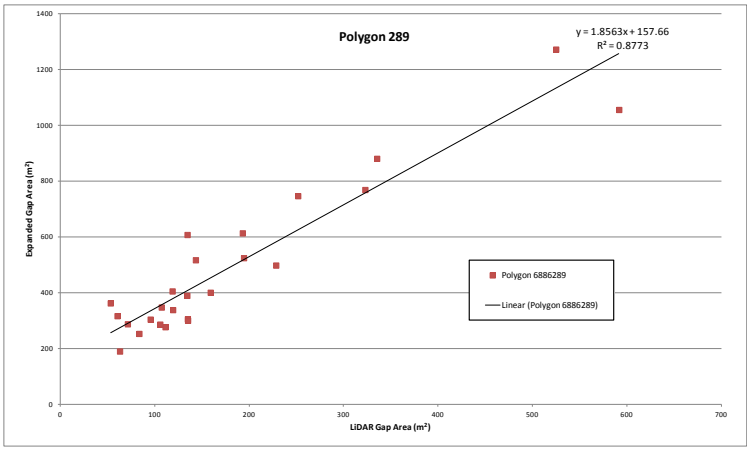


Figure 4.

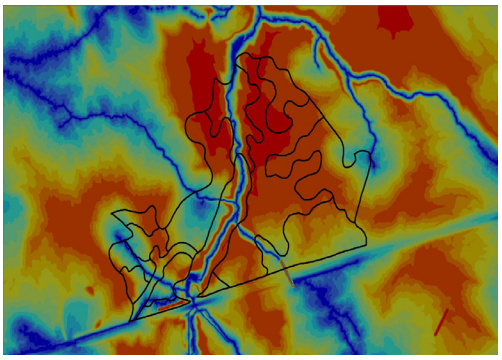


Figure 5.

Wood stiffness for uneven-aged stands of white spruce (Picea glauca (Moench) Voss) and trembling aspen *(Populus tremuloides Michx.)*

Derek Sattler, Phil Comeau and Alexis Achim

For several coniferous and deciduous species, radial maturation of wood stiffness has been shown to be influenced by radial growth rate, tree slenderness, and the vertical position within the tree. Stand-level factors, such as basal area per hectare also have the potential to affect radial patterns of wood stiffness. Identifying tree- or stand-level factors that affect wood stiffness in white spruce and aspen will lead to the development of practical models wood stiffness. These models could then be integrated into the Mixedwood Growth Model and used estimate the wood stiffness for simulated stands.

Pith-to-bark changes in wood stiffness (Modulus of Elasticity; MOE) were examined in white spruce and aspen trees sampled from mature, unmanaged stands located within the central mixedwood natural subregion of Alberta.

Knot-free test pieces (measuring 15 x 1 x 1 cm) were collected from white spruce and aspen trees and subjected to three-point bending tests. The test pieces were collected from pith-to-bark in order to examine how wood stiffness changes in association with cambial age and the distance from the pith (cm). An equation was then selected to represent the pith-to-bark changes as a function of cambial age or tree size. Additional covariates (e.g., growth rate, slenderness, etc.) were then tested within the equations in order to determine the best model.

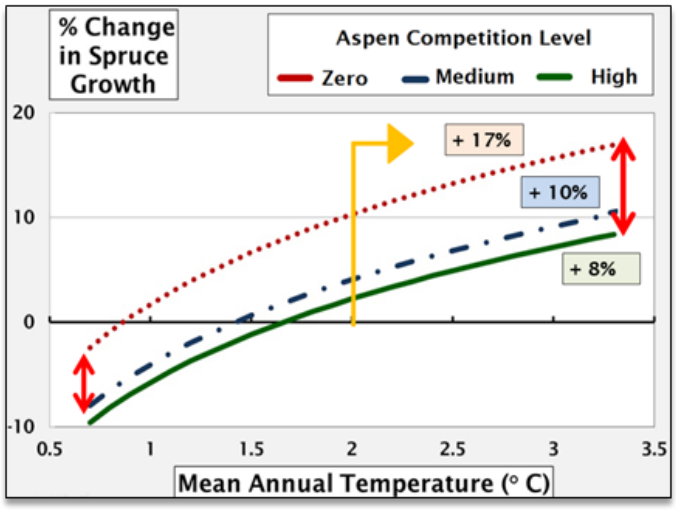
For white spruce and aspen, the radial maturation of wood stiffness was more closely associated with cambial age than tree size. Based on model predictions, wood stiffness should reach its maximum level at a breast-height cambial age of roughly 30 for white spruce and 45 for aspen. For white spruce, a slower radial growth rate and an increased slenderness reduced the number of years until maximum wood stiffness was achieved. No such effects were observed for aspen. For both species, maximum wood stiffness increased from tree-bottom to the base of the live crown.

The models developed for this study have potential use within the Mixedwood Growth Model. However, the models will need to be tested and then refined using data from silvicultural trails. Funding for this study is being provided by the For-ValueNet NSERC Strategic Network. More information on ForValueNet is available at: http://www.forvaluenet-foretvaleur.ca/

Trembling aspen competition and climate effects on white spruce growth in boreal mixtures of Western Canada

Francesco Cortini, Phil Comeau, and Mike Bokalo

We investigated the combined effect of trembling aspen competition and climate on white spruce growth using data from the WESBOGY long term study. Results indicate that competition (i.e., aspen basal area), initial size of the tree and mean annual temperature can account for 88% of the year to year variation in spruce volume growth for these six locations. Based on the model that we developed, spruce growth, in the absence of competition, is estimated to increase by up to 17% compared with an increase in mean annual temperature from 2 °C to 3.3 °C, while, at high levels of competition (aspen basal area = 27 m2 ha-1) spruce growth increases by only 8%. Moreover, effects of aspen on spruce growth increase more than proportionally as temperature increases. This outcome indicates that abundant aspen competition limits spruce responses to rising temperature, presumably due to competition for light and potentially increased competition for soil resources. Results also show that competition and climate effects vary between locations, indicating that spruce growth is strongly influenced by local factors such as micro-climate, topography, and soil properties.



This figure shows the percent change in predicted volume increment compared to the average value. The red double arrows indicate the increasing difference between scenarios at the extreme low and high temperature. The coloured text boxes indicate the percentage change in growth increase by scenario moving from 2°C to 3.3°C.

For more information see: Cortini, F, P.G. Comeau, and M. Bokalo. 2012. Trembling aspen competition and climate effects on white spruce growth in boreal mixtures of Western Canada. For. Ecol. Man. 277: 67-73.

Application of LiDAR in Forest productivity estimation

Introduction
Accurate determination of site index is critical to determining potential yield of regenerating stands and is a key input into growth and yield models used in Alberta. However, determining site index in spruce or aspen stands that are less than 15 years of age is problematic. While site index could be estimated from measurement of the original preharvest stand, this may be inaccurate due to: 1) the advanced age of the original aspen regeneration on the site (making accurate age determination problematic due to decay); and, 2) the fact that naturally regenerated spruce are rarely dominant but instead grow up under aspen and other vegetation during the first 60 to 80 years after regeneration. The use of ecological information, including both climatic and site factors, is being pursued in other areas. However, reliance on ground based assessments or predictive ecosystem mapping has limited its use. LIDAR and Wet Areas Mapping (WAM) may provide cost effective ways to obtain the needed ecological information, but while prelimary evaluations show that this approach is promising, it does need further development and testing.

With support from Alberta Environment and Sustainable Resource Development we are undertaking two projects to explore application of LiDAR in the estimation of site index.

A. High precision prediction of site index and future yield by use of wet areas mapping and full feature LiDAR
Gabriel Oltean (M.Sc. Student), Phil Comeau, Mike Bokalo, and Barry White (AESRD).

Objective: The objective of this project is to evaluate the potential to use Alberta's extensive wet areas mapping and full feature LiDAR datasets to estimate site index of aspen and spruce sites.

Approach: For this study we are using measurements collected at Alberta WESBOGY Long Term Study (LTS) sites (4 installations over 18 years old), and the Judy Creek Mixedwood research trial plots (25 plots, trees now 10 years old). Site Index is being determined for aspen and white spruce using measurements available for each site.
To verify the effectiveness of depth to water table measurements provided by WAM for estimating root zone soil moisture we will utilize data from existing microclimate stations installed at Judy Creek, and at the Fawcett Lake LTS site, and we will install microclimate stations to measure soil moisture in 4 selected plots at each of 4 selected installations (DMI Hines Creek, DMI Manning, SRD Fawcett Lake, Weyerhaeuser Grande Prairie). Daily volumetric soil moisture measurements will be collected at 15 cm depth in each instrumented plot and used to estimate degree and duration of drought at each site for comparison to WAM based estimates. Work on this project began in 2012. Completion of Gabriel's M.Sc. thesis is anticipated in 2014.

B. Prediction of future forest productivity and silvicultural challenges using Full Feature LiDAR, Wet Areas Mapping and Landform: A case study using the 1968 Marten Hills Fire
Ivan Bjelanovic (M.Sc. Student), Phil Comeau, Mike Bokalo, John Nash (Greenlink), and Barry White (AESRD).

Objective: To evaluate the potential to use depth to watertable as well as slope, aspect, macro- and meso-slope position as informed by LiDAR to estimate soil moisture regime, aspen and spruce site index and competing vegetation potential.

Approach: For this study we will utilize data from in the 1968 fire in management unit S17 with supplemental field sampling. We will use detailed inventory data based on LIDAR and 30cm digital photography, as well as field sampling to verify inventory estimates of site index.

A second part of this study will explore relationships between WAM estimates of soil moisture regime and the need for vegetation management treatments. This will involve selecting cutblocks and portions of cutblocks in the Slave Lake – Marten Hills area that have recently received vegetation management prescriptions (but which have not yet been treated) and examining relationships between soil moisture regime and species composition, cover and height of vegetation.

Work on this project will begin in the summer of 2013.

Results from these studies will form the basis for two M.Sc. theses and at least 2 papers in peer reviewed journals. Results will be presented to collaborating agencies and others as they become available.

Stand density index and productivity in boreal mixedwoods of Western Canada

Valentin J. Reyes-Hernandez and Philip G. Comeau

This study was designed to explore the use of measures of relative density, based on maximum size-density relationships (MSDRs) (Reineke 1933; Yoda et al. 1963), in management of boreal pure and mixed stands of trembling aspen (Populus tremuloides Michx.) and white spruce (Picea glauca (Moench) Voss.). Analysis of MSDRs has been completed (Reyes-Hernandez, et al. 2013), indicating that stand composition (percentage of basal area in deciduous species) determines the position and slope of the static MSDR line. In addition species proportion and site quality (Site Index) determine how individual stands develop and approach the self-thinning stage (dynamic self-thinning lines). It also appears that maximum stockability generally declines as the proportion of basal area in spruce increases.

Data analysis is ongoing to generate models for predicting understory light, and to explore the potential relationships between understory light regimes and relative density. In addition, relationships between current site occupancy (SDI and relative density), stand composition, and periodic annual increment are also being analyzed with data from permanent sample plots.

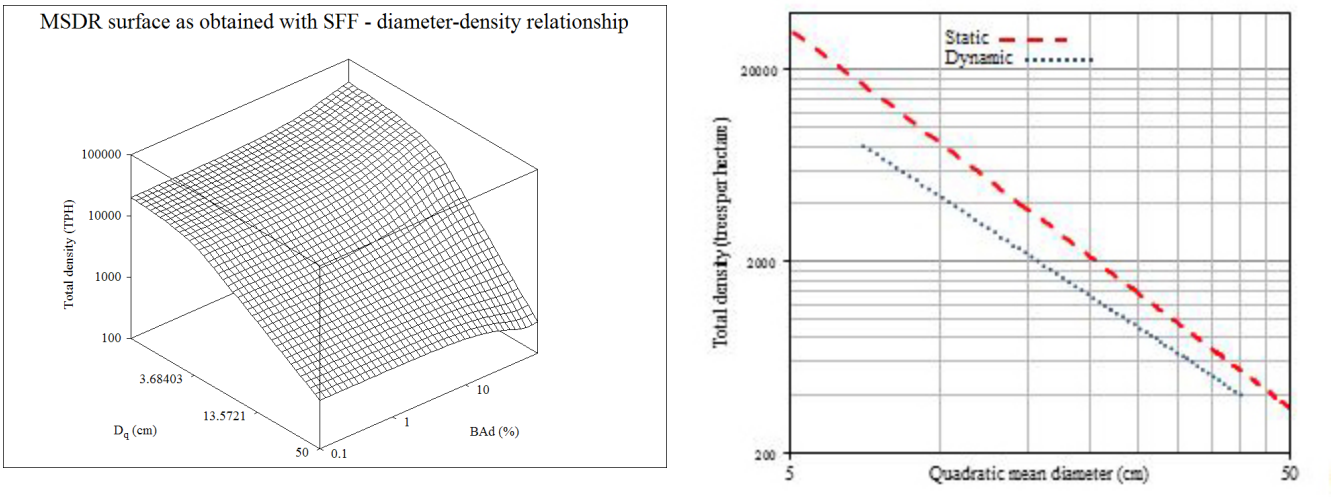


Figure 1 a) Maximum density (TPH)-diameter (Dq)- composition (% basal area deciduous) surface (a) for pure and mixed stands of aspen (Populus tremuloides Michx.) and white spruce (Picea glauca (Moench) Voss.); b) Diagram showing differences between static and dynamic self-thinning lines for boreal mixedwoods. (Figures modified from: Reyes-Hernandez et al., 2013. For. Ecol. Manage. 289: 300-311).

Judy Creek 2013

Graduate Students Working on Projects in the Western Boreal

Valentin Reyes-Hernandez (PhD) - Stand Density Index and its relationships with productivity and understory vegetation in the boreal mixedwoods in Western Canada

Hongan Yan (PhD) - The effects of competition control treatments on white spruce (Picea glauca [Moench] Voss) height and diameter growth

Derek Sattler (PhD) - Effects of density, species composition, age, and tree dimensions on wood quality for aspen and white spruce in boreal mixedwoods of western Canada (FORVALUENet Project 1.2)

Claudia Rivera-Rios (PhD) – Role of understory vegetation and effects of management practices on C cycling and sequestration in boreal mixedwood ecosystems

Kirk Johnson (MSc) – Influence of silviculture on the successional dynamics of mixedwood stands

Dan Jensen (MSc) – The use of Lidar and Wet Areas Mapping (WAM) in representing Stand Structure and Unproductive Gaps in Forest Stands

Gabriel Oltean (MSc) –Estimation of site productivity and potential growth of top height trees using a remotely sensed depth-to-water index

Ivan Bjelanovic (MSc) - Prediction of future forest productivity and silvicultural challenges using Full Feature LiDAR, Wet Areas Mapping and Landform: A case study using the 1968 Marten Hills Fire

2012 WESBOGY Annual Fall Meeting
United Church Camp
Swan River, Manitoba
September 11th and 12th, 2012

Sponsored by: LP Canada Ltd. – Swan Valley Forest Resources Division

Monday Sept. 10, 2012
Bus Departs from the University of Alberta

Tuesday Sept. 11, 2012
Mixedwood Growth Model (MGM) Update - Mike Bokalo
Riding Mountain PSPs - Paul LeBlanc
LiDAR Projects - Phil Comeau
Graduate Student Presentations; Dan Jensen and Kirk Johnson
Spatial Site Index linked to ecosite - Paul LeBlanc

Growth and Yield Forum - moderated by Paul LeBlanc

WESBOGY Business Meeting – (4:00 – 5:00)

Evening Dinner - BBQ Supper Sponsored by LP

Wednesday Sept. 12, 2012 – FIELD TOUR
Paul LeBlanc
Stop # 1a – Understory Protection of conifer (Cutblock WEF-806)
Stop # 1b – 2012 hail damage
Stop # 2 – 2012 blow down damage in hardwood stands
Stop # 3 – East & West Blue Lakes
Stop # 4 – Shell River Glacial Spillway
Stop # 5 – active logging (cutblocks MGL-052, MGL-053)
Stop # 6 - Understory Protection of conifer (Cutblock WJL-031)
Stop #7a – multi-cohort aspen stand (2 or 3 canopies, multi-aged)
Stop #7b – Alpine (high) WESBOGY site – (age 14 yrs as of fall 2012)

Planned WESBOGY Meetings in 2013

The 2013 Annual Spring Meeting is planned for April 24, 2013 on the University of Alberta campus. The 2013 Annual Fall Meeting will be sponsored by Weyerhaeuser and Canfor in Grande Prairie, Alberta on September 17th and 18th, 2013.

History of WESBOGY Meetings

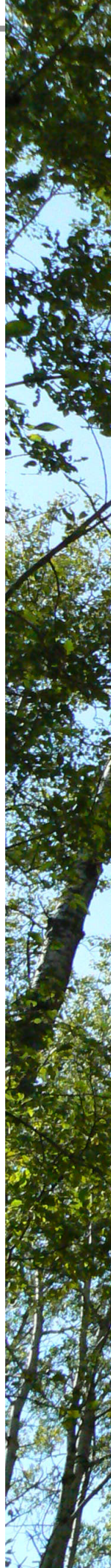
Date	Sponsor	Location
2012 Sept 11-12	Louisiana Pacific Canada Ltd.	Swan River, MB
2011 Oct 4-5	Daishowa-Marubeni International Ltd	Peace River, AB
2010 Sept 14-15	Manning Diversified Forest Products	Manning, AB
2009 Sept 15-16	University of Alberta	Whitecourt, AB
2008 Sept 8 -10	Alberta Plywood	Slave Lake, AB
2007 Sept 4-6	Alberta-Pacific Forest Industries	Lac La Biche, AB
2006 Aug 29-Sept 1	Louisiana Pacific Canada Ltd.	Dawson Creek, BC
2005 Aug 29 - Sept 1	Northwest Territories Resources, Wildlife and Economic Development	Hay River, NWT
2004 Aug 30 - Sept 1	Saskatchewan Environment – Forest Service	Prince Albert, SK
2003 Sept 9-11	Canadian Forest Products Ltd.	Grande Prairie, AB
2002 Sept 9-11	Louisiana-Pacific Canada Ltd.	Riding Mountain, MB
2001 Sept 9-11	Daishowa-Marubeni International Ltd.	Peace River, AB
2000 Sept 6-8	Weyerhaeuser Company, Drayton Valley	Edson, AB
1999 Sept 23-25	Weyerhaeuser Company, Prince Albert	Anglin Lake, SK
1998 Oct 7-9	Alberta-Pacific Forest Industries Ltd.	Athabasca, AB
1997 Oct 7-9	British Columbia Ministry of Forests	Dawson Creek, BC
1996 Nov 6-8	Daishowa-Marubeni International Ltd.	Peace River, AB
1995 Oct 11-13	Weldwood of Canada Ltd.	Hinton, AB
1994 Oct 12-14	Weyerhaeuser Company, Alberta Forestlands	Big River, SK
1993 Nov 4	University of Alberta	Edmonton, AB
1992 Oct 6-7	Weyerhaeuser Company, Grande Prairie	Grande Prairie, AB
1991 Oct 24-25	Weyerhaeuser Company, Prince Albert	Prince Albert, SK
1990 Nov 22	University of Alberta	Edmonton, AB
1989 Mar 15	Canadian Forest Service	Saskatoon, SK
1988 Nov 4	Canadian Forest Service	Whitecourt, AB
1998 Feb 4-5	Canadian Forest Service	HInton, AB
1987 Mar 27	Canadian Forest Service	Edmonton, AB
1986 Feb	Canadian Forest Service	Edmonton, AB
1985 Nov 15	Canadian Forest Service	Edmonton, AB
1985 Oct 24	Canadian Forest Service	Banff, AB
1985 Mar 23	Canadian Forest Service	Edmonton, AB

WESBOGY Website and Sharepoint Site

With the assistance of Judy Huck (U of A, Department of Renewable Resources Webmaster / Multimedia Technician) our new website is up and running. Changes include: having our own web address, a secure members area, and inclusion of both historical and current documents in readily accessible formats.

Check out our:

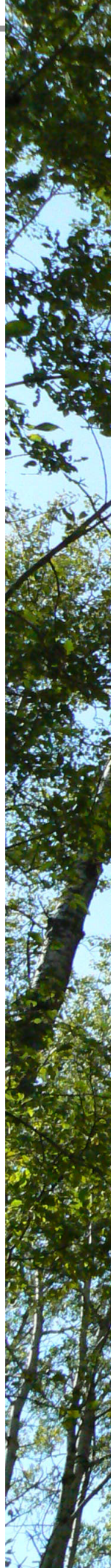
WEBSITE at: http://wesbogy.ualberta.ca
Sharepoint Site at: https://portal.ales.ualberta.ca/wesbogy/default.aspx



WESBOGY Financial Summary For 2012-2013

Description	Budgeted Amount	Actual Expenditures	Difference
Salaries & Benefits			
Research Scientist salary	$78,000	$78,777	($777)
Field and office tech support salary	$12,000	$13,473	($1,473)
Grad students/Research Projects (salary)	$4,000	$0	$4,000
Professional (MGM Programmer / Analyst)	$10,000	$7,000	$3,000
Travel (Wesbogy Meetings, travel & Judy Creek)	$8,500	$8,599	($99)
Supplies, Equipment, Communication, Vehicle rental	$6,000	$5,913	$87
Overhead (15% of member contributions)	$16,875	$16,875	$0
Overhead (20% of AESRD contributions)			
TOTAL	$135,375	$130,637	$4,738
Balance at March 31, 2013			
Opening Balance April 1, 2012	$167,126	$167,126	
Member Contributions (in Jan-March 2013)	$112,500	$112,500	
Expenditures 2012/2013	($135,375)	($130,637)	
Balance at March 31, 2013 (Main account)	$144,251	$148,989	
Balance at March 31, 2013 (AESRD contribution account)		$10,000	
Total Year End Balance		$158,989	
Accounts receivable		$10,625	
WESBOGY - Budget for 2013/14			
Description	**Amount**		
Salaries & Benefits			
Research Scientist	$100,000		
Field and office tech support	$16,000		
Grad students/Research Projects	$5,000		
Professional (MGM Programmer/Analyst)	$10,000		
Travel (Wesbogy Meetings, travel & Judy Creek)	$8,500		
Supplies, Equipment, Communication, Vehicle rental	$6,000		
Overhead (15% of member contributions, 20% AESRD)	$21,250		
TOTAL	$166,750		
Projected Balance at March 31, 2014			
Opening Balance April 1, 2013		$158,989	
Member Contributions (in Jan-March 2013)		$137,500	
Expenditures 2013/2014		($166,750)	
Accounts Receivable		$10,625	
Estimated Balance at March 31, 2013		$140,364	

Company or Agency	Contact	Email
Alberta Sustainable Resource Development	Dave Morgan (780) 422-5295 Darren Aitkin (780) 644-5581	Dave.Morgan@gov.ab.ca Darren.Aitkin@gov.ab.ca
Alberta-Pacific Forest Industries Inc.	Dave Cheyne (780) 525-8261 Gitte Grover (780) 525-8349	Dave.Cheyne@alpac.ca Gitte.Grover@alpac.ca
Canadian Forest Products Ltd.	Shayla Blue (780) 538-7740 Melonie Zaichkowky (780) 538-7720	Shayla.Blue@canfor.com Melonie.Zaichkowsky@canfor.com
Daishowa-Marubeni International Ltd.	Gord Whitmore (780) 624-7036 Frazer Butt (780) 624-7427	GWhitmore@dmi.ca FButt@dmi.ca
Louisiana-Pacific Canada Ltd., Manitoba	Paul Leblanc (204) 734-7724	Paul.Leblanc@lpcorp.com
Louisiana-Pacific Canada Ltd., Dawson Creek	Adam Campbell (250) 782-3302 ext 223 Rod Brooks (250) 782-3302 ext 239	Adam.Campbell@lpcorp.com Rod.Brooks@lpcorp.com
Manning Diversified	Steve Blanton (780) 836-5397	Steve.Blanton@mdfp.ca
Northwest Territories Resources, Wildlife and Economic Development	Mike Gravel (867) 874-2009 Lisa Smith (867) 874-2009 Tom Lakusta (867) 874-2009	Lisa_Smith@gov.nt.ca Mike_Gravel@gov.nt.ca Tom_Lakusta@gov.nt.ca
Saskatchewan Ministry of Environment	Phil Loseth (306) 953 - 3567 Nirmal Subedi (306) 953 - 2431	Phil.Loseth@gov.sk.ca Nirmal.Subedi@gov.sk.ca
University of Alberta	Phil Comeau (780) 492-1879 Mike Bokalo (780) 492-9038	Phil.Comeau@ualberta.ca Mike.Bokalo@ualberta.ca
Alberta Plywood Ltd. A Division of West Fraser Mills Ltd	Gary Harmata (780) 805-3718 Terry Kristoff (780) 804-3715	Gary.Harmata@westfraser.com Terry.Kristoff@westfraser.com
Weyerhaeuser Company, Alberta Forestlands	Greg Behuniak (780) 539-8207 Wendy Crosina (780) 451-9783	Greg.Behuniak@weyerhaeuser.com Wendy.Crosina@weyerhaeuser.com
Wood Fibre Centre, Canadian Forest Service, Natural Resources Canada	Dan MacIsaac (780) 435-7332 Derek Sidders (780) 435-7355	Dan.MacIsaac@NRCan-RNCan.gc.ca Derek.Sidders@NRCan-RNCan.gc.ca



Western Boreal Growth & Yield Association (WESBOGY)

C/O Department of Renewable Resources
University of Alberta
751 General Services Building
Edmonton, Alberta T6G 2H1

Phone: 780-492-4413
Fax: 780-492-4323
www.ales.ualberta.ca/rr/Research/WESBOGY.aspx

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