Western Boreal Growth and Yield Association

Annual Report 2015

Forest growth, yield, inventory and planning in western Canada

WESBOGY

www.WESBOGY.ualberta.ca

UNIVERSITY OF ALBERTA

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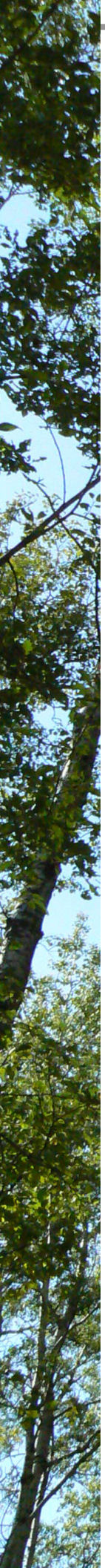


Executive Summary and Highlights

In 2014 members of the association continued 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. In 2014, the 30th annual fall meeting for the Western Boreal Growth and Yield Association was held in Candle Lake, Saskatchewan hosted by Saskatchewan Environment and the Canadian Forest Service. Current membership in the association includes seven forest companies, three provincial/territorial governments (Alberta, Saskatchewan and the Northwest Territories) and the federal government.

Data collection, cleaning and uploading of the long term study data to the sharepoint site continues. A manuscript looking at the past growth and mortality along with long term MGM projections of all WESBOGY installations is planned for the fall of 2015.

The development and application of the Mixedwood Growth Model continues to be a high priority of the association. The new version of MGM, MGM2015vs was demonstrated at the 2014 fall meeting in Candle Lake. The new version offers greater speed and better interaction with other programming languages improving it's utility in forest management planning. The approval process for MGM continued with the completion of the validation of MGM against the provincial growth and yield initiative (PGYI) dataset. In 2014, jack pine growth and mortality functions were developed, integrated into MGM and validated. The use and application of MGM in management planning was extensive in several projects in the ALPAC and Martin Hills FMA.

In 2014 graduate support and supervision was very active. Dan Jensen (M.Sc.) successfully defending his thesis examining the use of LiDAR and Wet Areas Mapping (WAM) to measure gap area in stands and impacts of gaps on stand level yields.

Kirk Johnson (M.Sc. student) continued his study examining the effects of establishment practices on dynamics of white spruce plantation in Saskatchewan. Kirk is expected to defend his thesis in the fall of 2015.

Gabriel Oltean (M.Sc. student) is looking at the prediction of site index and future yield using wet areas mapping and full feature LiDAR. Gabriel is expected to defend his thesis in the fall of 2015.

Ivan Bjelanovic (M.Sc. student) started his project in 2013. It is a case study using the 1968 Marten Hills Fire to determine if the prediction of future forest productivity can be enhanced using Full Feature LiDAR, Wet Areas Mapping and Landform. Ivan completed his field work in the summer of 2014.

In 2014, we have also welcomed some new graduates students. Valerie Krebs (MSc) is looking at refining models of white spruce release following strip cut understory protection harvesting, Felix Oboite (MSc) is studying the growth of advance spruce regeneration following mountain pine beetle attack , and Deogkyu Kweon (PhD) is interested in the over-yielding, self-thinning and drought resistance in young boreal mixedwood stands.
Phil Comeau and Mike Bokalo have also initiated new projects looking at "Improving the estimation of tree mortality and stand breakup", "Improving site index estimation for Alberta" and "Enhancing Growth and Yield Data Collection Methods Using Airborne Image Technology". These projects are designed to continue to increase our knowledge base and understanding of the western boreal forest and to increase our efficiency in managing our forest resources.

This Annual Report presents highlights of work accomplished during 2014 and outlines major activities planned for 2015.

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.

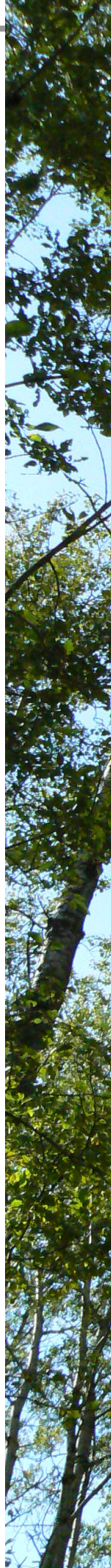
To foster communication, cooperation and exchange of information among the Members as well as various agencies and groups concerned with management and development of boreal forests.

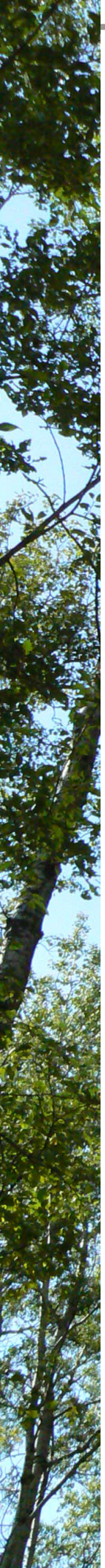
To focus on the dynamics of mixedwood stands of aspen and white spruce growing in the boreal forest. Basic relations to be studied will include establishment, ingrowth, growth, and mortality. While the major species of interest are aspen and white spruce, other species such as balsam poplar, lodgepole 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.



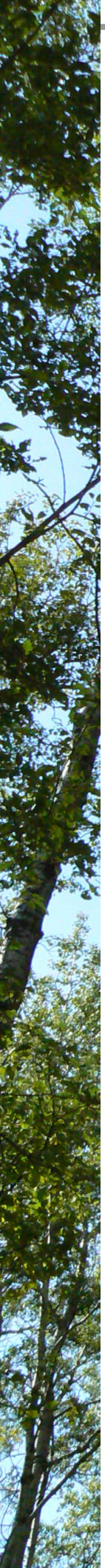


5-Year Objectives

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

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 was carried out. A manuscript with ANOVA results as well as MGM projections is planned for late 2015. **Researchers**: Mike Bokalo, Phil Comeau, Susan Humphries
Siphon Creek and Bear Mountain	**Status**: These two studies 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). The results have been submitted to a journal for publication. **Researchers**: Richard Kabzems Mike Bokalo, Phil Comeau, Dan MacIsaac and Susan Humphries
MGM Development	
Validation of MGM2010A with independent PYGI dataset	**Status**: Data Received in Feb 2014, compilation and validation completed. Report to be submitted to AESRD in July of 2015. **Researchers**: Mike Bokalo and Phil Comeau
MGM Height, Diameter and Mortality Functions for jack pine	**Status**: Funded by Saskatchewan Environment, Alberta Pacific Forest Industries and Alberta Environment and Sustainable Resource Development. Growth and mortality functions have been developed, implemented in MGM, and validated. A final report to the funding agencies is planned for April 2015. **Researchers**: Vlad Strimbu, Mike Bokalo and Phil Comeau
Conversion of MGM to Visual Basic Stand Alone	**Status**: Initiated in 2012 and currently underway. Alpha version now available and being tested. **Researchers**: Mike Bokalo and Phil Comeau
Associated Research Projects	
The use of LiDAR and Wet Areas Mapping in representing Stand Structure and Unproductive Gaps in Forest Stands	**Status**: Initiated in 2011; Thesis successfully defended in December 2014. Publication in prep. **Researchers**: Dan Jensen (M.Sc. student), Mike Bokalo, Phil Comeau and Barry White
Influence of silviculture on the successional dynamics of mixedwood stands	**Status**: Initiated in 2011 with funding from Saskatchewan Environment. Thesis defense is expected in Sept. 2015. **Researchers**: Kirk Johnson (M.Sc. student), Phil Comeau and Mike Bokalo
High precision prediction of site index and future yield by use of wet areas mapping and full feature LiDAR	**Status**: Initiated in 2012. Thesis defense is expected in Sept. 2015. **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**: Initiated in 2014. **Researchers**: Ivan Bjelanovic (M.Sc. student), Phil Comeau, Mike Bokalo, and Barry White
Stand dynamics following canopy removal and release of advance regeneration in aspen and lodgepole pine dominated stands	**Status**: Initiated in 2014. **Researchers**: Valerie Krebs (M.Sc. student), Felix Oboite (PhD student), Phil Comeau, Mike Bokalo, Greg Behuniak (Weyerhaeuser), Vic Lieffers, Ellen Macdonald, Gitte Grover (ALPAC), Ken Stadt (AESRD), Dan MacIsaac (CWFC), Derek Sidders (CWFC).
Enhancing Growth and Yield Data Collection Methods Using Airborne Image Technolog	**Status**: Initiated in 2014. **Researchers**: Mike Bokalo. Phil Comeau, Derek Fisher (Greenlink) and Matt Kristoff (Greenlink).
Improved estimation of tree mortality and stand breakup	**Status**: Initiated in 2014. **Researchers**: Phil Comeau, Mike Bokalo, and Francesco Cortini (University of Alberta), Terry Kristoff (Alberta Plywood), Ted Hogg (CFS), Shongming Huang (Alberta Agriculture and Forestry), and Gitte Grover (AlPAC).
Improving site index estimation for Alberta	**Status**: Initiated in 2014. **Researchers**: Phil Comeau and Mike Bokalo (Univ. of Alberta), Tim McCready (Millar Western Contractors), Yuqing Yang (Alberta Agriculture and Forestry).

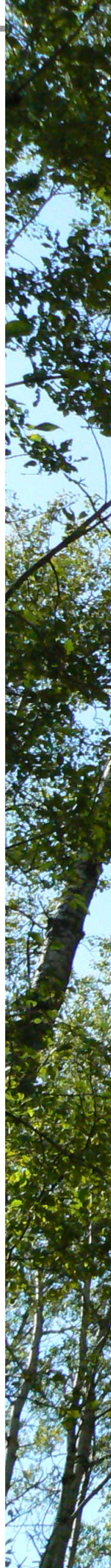
Membership

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
2013 Comeau, Bokalo, Leblanc, Whitmore, Blue
2014 Comeau, Bokalo, Leblanc, Aitkin, Kristoff



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 2014/15 with all members actively participating. Redesign of the Sharepoint site is underway in order to take advantage of the features available in the new version. The LTS manual continues to evolve as new data collection challenges arise. Analysis and preparation of a new manuscript outlining the growth and mortality of all the WESBOGY installations has begun with a target publication date in late 2015 or early 2016.

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.

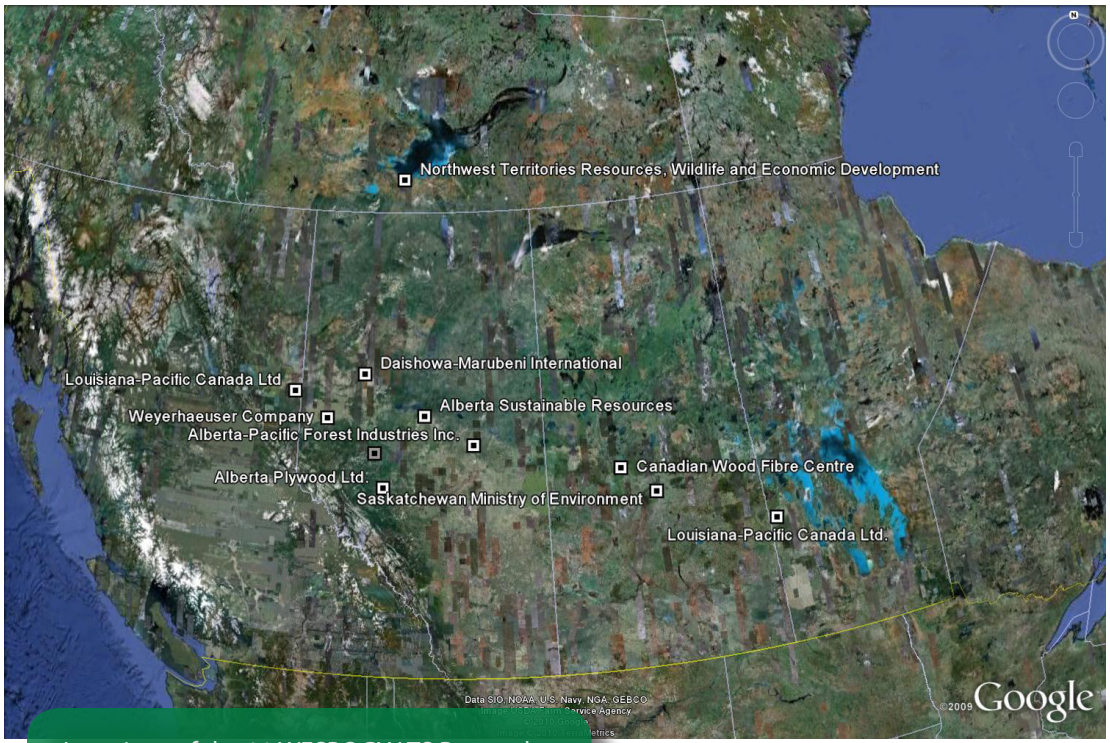
Filipescu, C.N. and P.G. Comeau. 2007. Aspen competition affects light and white spruce growth across several boreal sites in western Canada. Can. J. For. Res. 37: 1701-1713.

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 2013
Alberta Sustainable Resource Development	SRD	Med	1992	22
Alberta-Pacific Forest Industries Inc.	ALP	High Med	1994 2001	21 13
Canadian Forest Products Ltd.	CFR	High Med	2000 2001	14 13
Daishowa-Marubeni International Ltd.	DMI	High Med	1992 1992	22 22
Louisiana-Pacific Canada Ltd., Manitoba	LPSR	High Med	1998 1998	16 16
Louisiana-Pacific Canada Ltd., Dawson Creek	LPDC	High Med	2001 2004	13 11
Northwest Territories Resources, Wildlife and Economic Development	NWT	High Med	1993 1993	21 21
Alberta Plywood	WFR	High Med	1992 1993	20 20
Weyerhaeuser Company, Alberta Forestlands	WGP	High Med	1991 1991	23 23
Saskatchewan Ministry of Environment	SSK	High Med	1990 1990	24 24
Wood Fibre Centre, Canadian Forest Service	CFS	High Med	1992 1992	22 22



Locations of the 11 WESBOGY LTS Research Installations

MGM Development

Mike Bokalo, Phil Comeau and Steve Titus

The development and use of MGM continued in 2014. There were 4 key areas of focus; 1) the transition of programming of MGM from Steve Titus to Mike Bokalo, 2) the continued development of MGM2015vs, 3) support for the application of MGM in management planning, 3) the calibration, implementation and validation of the MGM for jack pine and, 4) continue work on obtaining formal approval of MGM for use in management planning in Alberta by validating MGM using the independent provincial growth and yield initiative (PGYI) dataset.

Model approval for use in management planning in Alberta
As part of the AESRD approval process, the validation of MGM on an independent dataset provided under the provincial growth and yield initiative (PYGI) was carried out. Formal report submission is planned for July 2015. This validation provided more than 500 new PSP's for an independent validation.

MGM Software Development
The new version of MGM2015vs involves migration to the Visual Studio platform. This permits better integration of MGM with Excel and Visual Basic. Under the new platform, MGM is a compiled program making it more portable and faster and allows for better integration with other programs such as SAS and Microsoft Access. The alpha version has seen the core growth and mortality functions re-written and compiled in Visual Basic. The redevelopment process included a vigorous validation process to ensure that results from the earlier version of MGM corresponded to results from the new version. A comparison of the MGM3099 version with the MGM2015vs version will be submitted to AESRD in the fall of 2015 with the objective of demonstrating that these two version of MGM are equivalent.

MGM Jack Pine Calibration
This cooperative project funded by the Saskatchewan Environment, Alberta Pacific Forest Industries and the Alberta Environment and Sustainable Resource Development was completed in 2014 . The project was to parameterize MGM for jack pine. The project first developed height and diameter increment relationships, and mortality functions for Jack pine using existing Saskatchewan, Alberta and Manitoba PSP data. The new equations were coded into MGM and then validated. The final report was submitted to the funding agencies in April of 2015.

MGM Wood Quality
In a cooperative project with Jim Stewart at the Canadian Forest Service, the first components of a MGM module that outputs annual growth data needed for wood quality predictions was developed. This project will continue into 2015 with the full development of the modules.

MGM Documentation and Website
The MGM documentation and website has been updated and enhanced in order to meet regulatory requirement of full model disclosure. The MGM Website (MGM.ualberta.ca) offers a publicly accessible portal for downloading MGM.

Application of MGM
There has been continued development and demonstration of MGM's capability to model different tending/treatments scenarios. Several projects were initiated in 2013 and continued in 2014 that have moved MGM from a research model to a model used in forest management planning.

In late 2013, ALPAC was granted permission by ASRD to use MGM in the development of yield curves for treated managed stands. During 2014, Mike worked closely with ALPAC in providing technical assistance in using MGM for yield curve development.

Tolko, Alberta Plywood and Vanderwell representing the Martin Hills FMA began the process of developing yield curves for understory protection stands. MGM was selected as a candidate model to predict future development of these spatially and vertically structured post harvest understory protection stands. Mike is taking an active role in assisting in the data acquisition, compiling and modeling with MGM.

High precision prediction of site index and future yield by use of wet areas mapping and full feature LiDAR

Gabriel Oltean (M.Sc. Candidate, Univ. of Alberta), Phil Comeau (Univ. of Alberta), Mike Bokalo (Univ. of Alberta)

Accurate estimates of site index are a key input into forest growth and yield models, such as MGM, that forecast development of regenerating stands. Obtaining site index estimates from the previous stand is difficult because the old aspen trees are frequently decayed and age cannot be accurately determined, while spruce are often suppressed by the overtopping aspen and do not reflect site conditions. The Government of Alberta has acquired accurate digital elevation models derived from LiDAR point clouds, and has supported development of Wet Areas Mapping for the green zone in Alberta thus creating the opportunity to use topographic indices as a proxy for site and soil properties which control site productivity.

The depth-to-water (DTW) index (Fig. 1), developed at the University of New Brunswick, integrates the horizontal and vertical distance from any cell in the landscape and the nearest flow channel, as a source of water. Several studies have shown that DTW can outperform other topographic indices when predicting soil properties. Our previous results have shown that DTW is related to site and soil properties related to soil moisture availability, but cannot capture other important attributes such as nutrient regime or texture.

We have recently completed an evaluation of the potential to use DTW to estimate site index of aspen and better predict future yield of aspen stands. We obtained aspen tree height measurements from four WESBOGY sites in Alberta (DMI, SRD, WGP) and Judy Creek to and tested how site index relates to plot averages of DTW, flow accumulation and slope.

Soil moisture and nutrient regime assessed in the field explained up to half of the variation in aspen SI, while the model using DTW was somewhat weaker (Fig. 2). This might be due to DTW's inability to represent nutrient availability and higher level site properties. Our results suggest that DTW must be considered in future studies but additional information is required to accurately estimate site index.

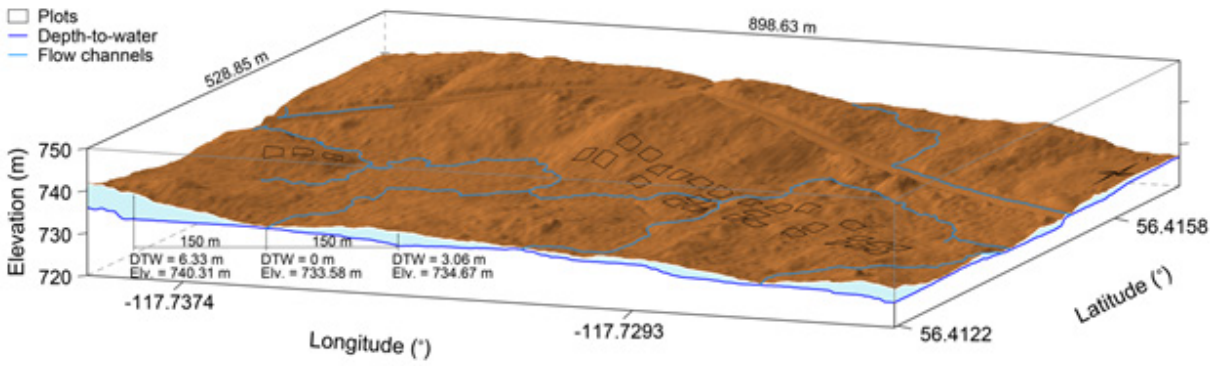


Figure 1. Topography, flow channels and DTW for the DMI LTS site north of Peace River

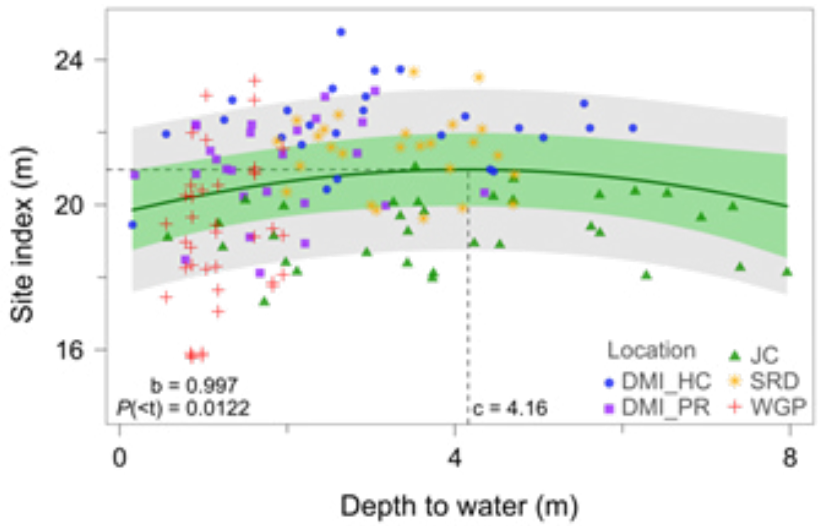


Figure 2. Confidence (green) and prediction (gray) intervals for the aspen site index model with DTW.

Assessing juvenile growth and modeling long-term outcomes in Saskatchewan white spruce plantations

Kirk Johnson (M.Sc. candidate), Phil Comeau (Univ. of Alberta), Mike Bokalo (Univ. of Alberta)

Project Funded by the Saskatchewan Ministry of Environment -

In Saskatchewan, white spruce (Picea glauca) plantations are often established using mechanical site preparation and cleaning. These silvicultural techniques encourage plantation success and can strongly influence short-term growth, composition, and yield. To assess silvicultural effects and model long-term managed stand growth, 16 white spruce plantations (13-18 years old) and 18 white spruce PSP's (20-29 years old) were sampled across the Prince Albert Forest Management Agreement in 2011 and 2012.

Site preparation and tending effects were evaluated across the 16 juvenile white spruce plantations. Preliminary analysis indicates that white spruce height did not differ between Bracke mounding, v-plow scarification, disc trenching, and disc trenching + cleaning treatments. However, v-plow scarification may increase white spruce DBH relative to Bracke mounding. Operational treatments and site differences complicated silvicultural analysis. In addition, plantations without mechanical site preparation or tending (i.e. untreated control) could not be located, limiting silvicultural inference.

Using repeated measurements in the PSP dataset, short-term MGM projections (1996-2011) were also compared to observed juvenile growth. Site index assumptions largely dictated MGM performance. However, given accurate site indices, modelled white spruce height and DBH tracked observed growth in spruce-aspen mixedwoods. Modeled white spruce height and DBH were also overestimated in juvenile stands with heavy conifer competition. Since many factors influence young white spruce (e.g. browsing, frost damage, leader whip, woody/herbaceous competition) and juvenile site indices are difficult to define, initializing MGM with young stands (i.e. less than 15 years old) may be problematic.

Finally, long-term growth (120-year rotation) was modelled in MGM using the 16 white spruce plantations and 18 white spruce PSP's. Juvenile mixedwood stands with a strong white spruce component (~2000 trees/hectare) and intermediate levels of deciduous competition are expected to achieve softwood-leading (>75% conifer basal area) or softwood-leading mixedwood (50-75% conifer basal area) status by age 90. Increasing deciduous competition slowed modelled succession but did not prevent hardwood-leading stands from becoming mixedwoods by age 120. Site index assumptions strongly influenced modelled succession and long-term outcomes. Project completion is expected by Fall 2015.

Bracke mounded plantation near Candle Lake, SK. This site was planted in 1988 and cleaned in 1991.

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. candidate), Phil Comeau (Univ. of Alberta), Mike Bokalo (Univ. of Alberta), and Barry White (Alberta ESRD).

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. Site Index prediction models based on the relationship between environmental factors and site index can overcome some of the problems and challenges associated with determining Site Index. High resolution LiDAR generated Digital Elevation Models(DEM) combined with LiDAR derived depth-to-water and flow accumulation indexes from Wet Area Mapping (WAM) in Alberta provide access to high resolution estimates of ecological information that could be used in predicting Site Index.

The objective of this study is to evaluate the potential use of environmental variables derived from remote sensed and ground based determination of ecological site characteristics in the estimation of Site Index. A network of temporary sample plots was established in Central Alberta (the area of 1968 Vega fire in the southern portion of management unit S17) to examine these relationships. Field sampling was conducted across a broad range of depth-to-water, and site conditions for the main tree species in the area (aspen, lodgepole pine, and white spruce) with a target of sampling 100 plots for aspen, and 50 plots for pine and spruce.

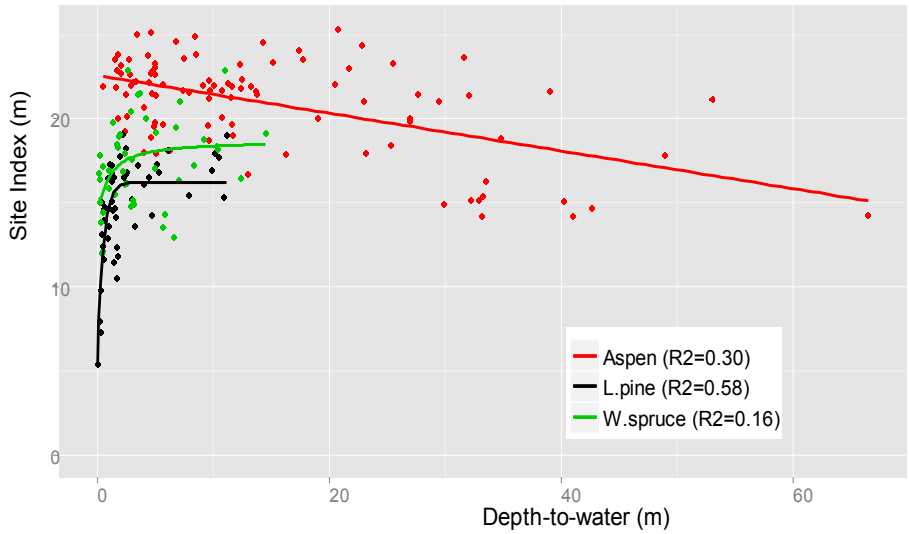


Fig. Relationship between Depth-to-water and Site Index for Trembling aspen, Lodgepole pine, and White spruce.

Preliminary results (Table.) show that Site Index can be predicted from biophysical factors. Using remotely sensed environmental data is as good as using field measurements. Differences in the strength of relationships between Site Index and environmental variables for different species are due to difference in species silvics. Depth-to-water, flow accumulation, altitude, and slope have proven as the best predictors. Models with WAM indexes (depth-to-water and flow accumulation) by themselves explain 44% aspen SI variation, 58% of pine SI variation, 28% of spruce SI variations.

Table. Adjusted R^2 and RMSE (m) from selected models for different data sources, modeling approaches, and species.

	Model Adjusted R^2 (RMSE)			
	Remotely sensed		Ground-based	
	Parametric	Non-parametric	Parametric	Non-parametric
Aspen	0.55 (1.85)	0.64 (1.65)	0.60 (1.76)	0.48 (1.97)
L. Pine	0.68 (1.69)	0.63 (1.80)	0.72 (1.57)	0.59 (1.89)
W. Spruce	0.34 (2.15)	0.45 (1.95)	0.49 (1.90)	0.48 (1.89)

We are grateful to Alberta Agriculture and Forestry (formerly Alberta Environment and Sustainable Resource Development) for providing funding to support this research.

Refining models of white spruce release following strip cut understory protection harvesting

Valerie Krebs (Univ. of Alberta, M.Sc. candidate) and Phil Comeau (Univ. of Alberta)

In summer 2014 and 2015 data was collected from 5 strip cut understory protection harvesting (scup) sites which included MWMA-SCUP installations, selected CFS-Adaptive Mixedwood study sites and EMEND. Purpose of the study is to investigate the effects of intraspecific competition on the growth of white spruce (Picea glauca) after strip cut harvesting and to incorporate the results in the Mixedwood Growth Model (MGM) to improve its accuracy.

Results show that there is a significant positive growth response of the white spruce following understory protection harvesting. Basal area increment begins to increase the year following harvesting (Fig.1), with increases in height increment beginning to occur about 3 years after harvest. Competition from other conifers has a significant and negative impact on spruce basal area increment (Fig.2) while aspen is not having significant effects.

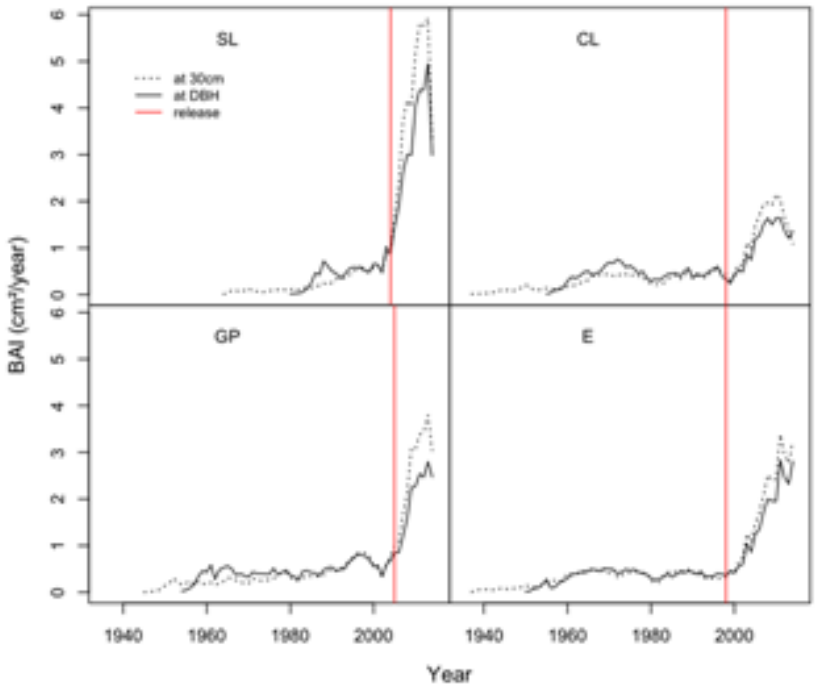


Figure 1: BAI over time at 4 study sites, red line reflects year of scup.

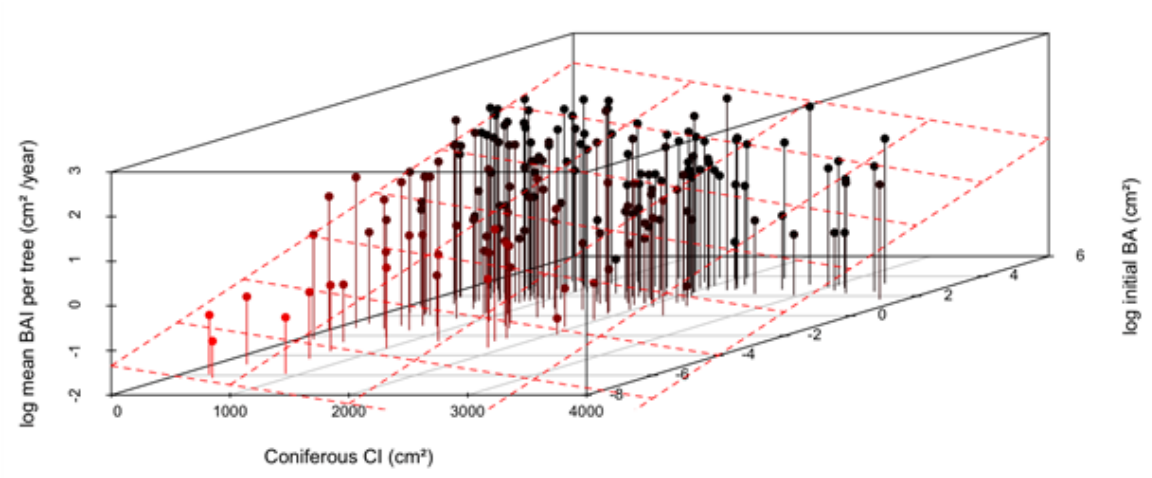


Figure 2: Relationship between BAI, coniferous competition (CI=sum of conifer basal area in a 5.64 m radius plot) and initial BA.

Improved estimation of tree mortality and stand breakup (FRIAA Project FFI-14-007)

Phil Comeau, Mike Bokalo, and Francesco Cortini (University of Alberta), Terry Kristoff (Alberta Plywood), Ted Hogg (CFS), Shongming Huang (Alberta Agriculture and Forestry), and Gitte Grover (AlPAC)

Current mortality models implemented in the Mixedwood Growth Model (MGM) are based on equations adapted from Yao et al (2003) and Yang et al. (2006) and rely on tree age, tree vigour and competition and do not perform consistently in predicting mortality and breakup of mature and overmature stands. As a consequence, while MGM validates well on average for Alberta mixedwood stands, it does not perform well for characterizing the successional dynamics of aspen and mixedwood stands that experience stand breakup earlier or later than the average. Recent research indicates that drought and other climate factors have significant influences on tree mortality in the boreal forest suggesting that their inclusion in models could be valuable.

A substantial body of additional PSP data has recently become available for Alberta through the development of a Provincial Growth and Yield Database by the Alberta Forest Growth Organization (AFGO). PSP datasets have also been assembled in Manitoba, Saskatchewan, NWT, Yukon, BC and Alaska. In addition, development of climate interpolation models now allows estimation of climate data for any location in Canada. These advancements in availability of plot data and climate data make it possible to complete a more detailed analysis of stand mortality for the boreal, montane and subalpine regions of western Canada.

The objective of this 3 year project, which started in January of 2015, is to develop improved models of survival probability for trembling aspen, balsam poplar, white spruce, black spruce, lodgepole pine, jack pine, balsam fir, subalpine fir, interior (hybrid) spruce, Engelmann spruce, and Interior Douglas-fir based on data from permanent sample plots in western Canada and Alaska. Models will consider interacting effects of climate, insects, tree size, tree age, stand characteristics (ie. density and composition), site and other factors. Resulting equations will be incorporated into the Mixedwood Growth Model and will be available for use in other models.

Improving site index estimation for Alberta

Phil Comeau and Mike Bokalo (Univ. of Alberta), Tim McCready (Millar Western Contractors), Yuqing Yang (Alberta Agriculture and Forestry)

Site index is the primary estimator of potential productivity in the growth and yield models that are widely applied in Alberta. While it can be readily determined for stands where there are healthy top height trees close to reference age for the species of interest it is difficult to determine when healthy top height trees are not present or where estimates of site index are required for advance regeneration or for species not currently present in the stand.

The use of ecological information, such as ecological site classification or ecological site factors to estimate site index is being pursued in many areas. The recent development of Wet Areas Mapping and accurate digital elevation models based on LIDAR also provides the opportunity to use remote sensing to obtain much of the ecological information that is needed for site index estimation. Models that include effects of both climate and site factors on productivity could be useful in modeling climate change impacts on forest productivity and growth and yield. In addition, models that use climate information directly, instead of relying on subregion designations, may work better for localizing site index estimates. Growth intercept models offer an alternative or supplemental approach that can be used to estimate site index for young trees or for advance regeneration after release.

Three major components of this project are: 1) Development of ecologically based site index predictors for regenerated post-harvest stands based on collection of field data from aspen, white spruce and lodgepole pine stands that are between 25 and 70 years of age; 2) Development of growth intercept models for young aspen, white spruce and lodgepole pine; and 3) Development of growth intercept models for advance regeneration of white spruce, following understory protection harvesting. This project is being funded by the Forest Resource Improvement Association of Alberta under the FRIP Program. Work on the project began in 2015 and will be completed by the end of 2018.

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. This study showed 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 un-merchantable gaps. It also showed that WAM was able to 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. Dan successfully defended his thesis in December 2014.

Enhancing Growth and Yield Data Collection Methods Using Airborne Image Technology

Mike Bokalo. Phil Comeau, Derek Fisher and Matt Kristoff (Greenlink).

This project investigates whether the high resolution image technology has reached a point in development where it can be used to collect TSP and PSP data while reducing the need for costly field sampling programs. The project also explores the possibility of automating these technologies to further enhance efficiency. The objective are; 1) to evaluate and assess the accuracy and precision of the data collected from high resolution 6cm digital multispectral Imagery by comparing it to data collected in the field for a range of stands, species mixtures, ages and densities, 2) Develop protocols, guidelines and identify limitations with respect to the collection and use of these image technologies, 3) enhance our understanding and potential benefits of the semi global matching algorithm with respect to its development and application in automating forest inventory and data collection.

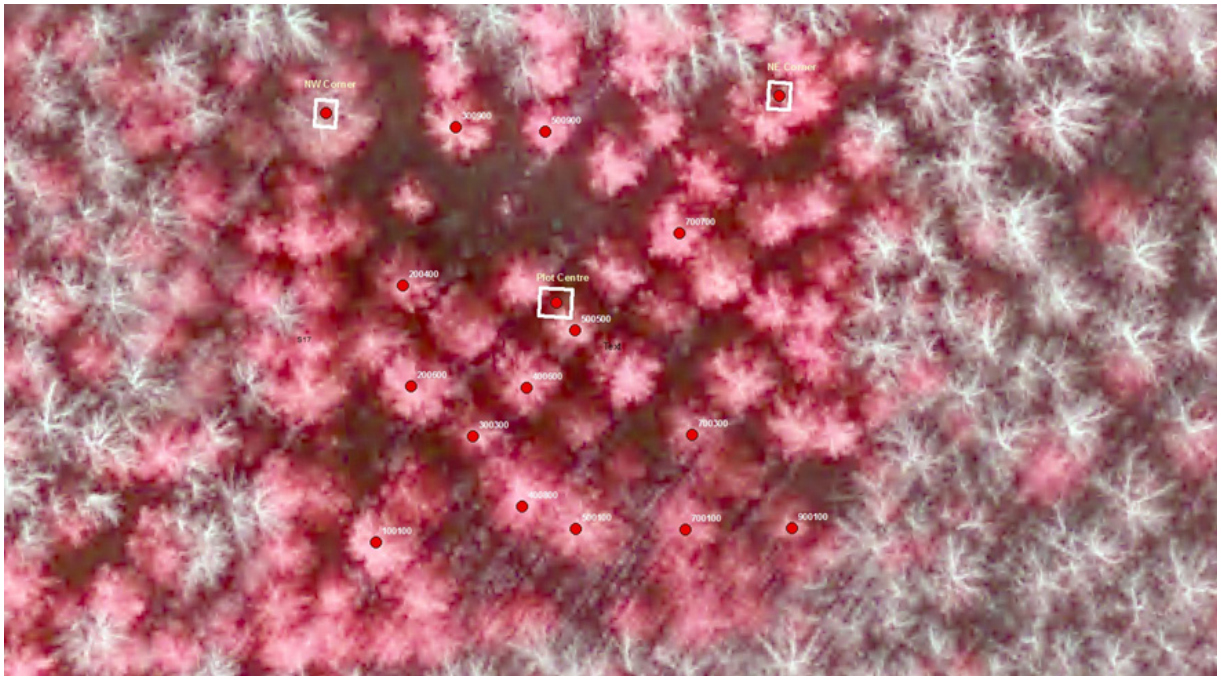


Figure 1: High resolution digial IR image of AESRD WESBOGY Pure Conifer Plot

Graduate Students Working on Projects in the Western Boreal

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

Valerie Krebs (MSc) - Refining models of white spruce release following strip cut understory protection harvesting

Felix Oboite (PhD) - Growth of advance spruce regeneration following mountain pine beetle attack.

Deogkyu Kweon (PhD) - Overyielding, self-thinning and drought resistance in young boreal mixedwood stands

30th Annual WESBOGY fall meeting
Candle Lake Golf Resort, Candle Lake, SK
Sept. 16 & 17th, 2014
Hosted by:
Saskatchewan Environment and the Canadian Forest Service

Monday Sept. 15, 2013
Evening Mixer: Informal Evening Mixer - Candle Lake Resort Lounge

Tuesday Sept. 16, 2013
• MGM Jack Pine - Calibration and validation results and demo - Mike Bokalo

• Grad Student Presentations:
Dan Jensen, Kirk Johnson, Gabriel Oltean, Ivan Bjelanovic, Valerie Krebs

• Can mixedwood management mitigate climate change impacts on spruce in western Canada's boreal forests? -Phil Comeau

• Navigating in the Fog: Wood Supply in a Changing Climate -Saskatchewan's Island Forests (Lane Gelhorn, Sk Environment)

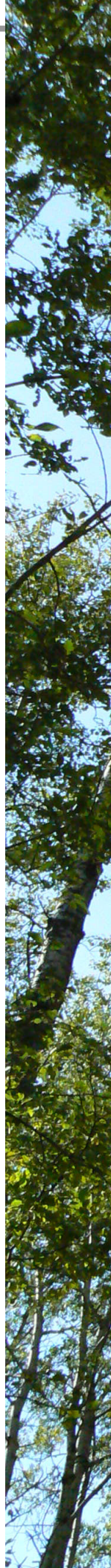
Growth and Yield Forum:
Discussion of what members are doing in relation to potential impacts of climate change on timber supply

WESBOGY Business Meeting (3:30 to 5:00)
6:00 pm - BBQ SUPPER (Sponsored by Saskatchewan Environment)

Wednesday Sept. 17th - Field Tour
Stop: 2013-14 Mixedwood cutover
Stop: Wesbogy Prince Albert Installation
Stop: Intensively managed 1987 cutover (Site Prep, planted ws, aspen cleaning)
Stop: Aspen Cutover LFN
Stop: Historic Mixedwood Trial with Aspen Removal MS-153

WESBOGY Financial Summary For 2014-2015

Description	Budgeted Amount	Actual Expenditures	Difference
Salaries & Benefits			
Research Scientist salary	$100,000	$97,711	$2,289
Field and office tech support salary	$16,000	$15,398	$602
Grant and Project Management	$0	$0	$0
Grad students/Research Projects (salary)	$5,000	$4,876	$124
Professional (MGM Programmer / Analyst)	$14,000	$0	$14,000
Travel (Wesbogy Meetings, travel & Judy Creek)	$9,000	$4,901	$4,099
Supplies, Equipment, Communication, Vehicle rental	$6,200	$6,345	-$145
Subtotal	$150,200	$129,231	$20,969
Overhead	$21,250	$19,385	$1,865
TOTAL	$171,450	$148,615	$22,835
Balance at March 31, 2015			
Opening Balance April 1, 2013		$96,731	
Funds received April-Dec 2014 (CFS and AESRD)		$26,200	
Overhead on Funds received April-Dec		-$2,500	
Net funds available 2014-2015		$120,431	
Balance (deficit) March 2015 (before dues for 2015)		-$8,800	
WESBOGY - Budget for 2015 (April 1 2015 – December 31 2015)			
Description	Amount		
Salaries & Benefits			
Research Scientist	$73,440		
Field and office tech support	$14,000		
Grant and Project Management	$0		
Grad students/Research Projects	$6,000		
Professional (MGM Programmer/Analyst)	$0		
Travel (Wesbogy Meetings, travel & Judy Creek)	$9,200		
Supplies, Equipment, Communication, Vehicle rental	$6,000		
Subtotal	$108,640		
Overhead	$16,296		
TOTAL	$124,936		
Projected Balance at December 31, 2016			
Opening Balance April 1, 2015		-$8,800	
Net funds available 2015 (Member dues @$12,500/member)		$137,500	
Projected Balance (December 31st, 2015)		$3,764	



Planned WESBOGY Meetings in 2014

The 2015 Annual Spring Meeting is planned for April 21, 2015 on the University of Alberta campus. The 2015 Annual Fall Meeting will be sponsored by Alberta Forest Industries in Lac La Biche, Alberta on September 15th and 16th, 2015.

History of WESBOGY Meetings

Date	Sponsor	Location
2014 Sept 16 - 17	Saskatchewan Envrionment and the Canadian Forest Service	Candle Lake, SK
2013 Sept 17 - 18	Weyerhaeuser and Canadian Forest Products	Grande Prairie, AB
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

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

Company or Agency	Contact	Email
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Alberta-Pacific Forest Industries Inc.	Dave Cheyne (780) 525-8261 Gitte Grover (780) 525-8349	Dave.Cheyne@alpac.ca Gitte.Grover@alpac.ca
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Daishowa-Marubeni International Ltd.	Frazer Butt (780) 624-7427 Gord Whitmore (780) 624-7036	FButt@dmi.ca GWhitmore@dmi.ca
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Manning Diversified	Steve Blanton (780) 836-5397	Steve.Blanton@mdfp.ca
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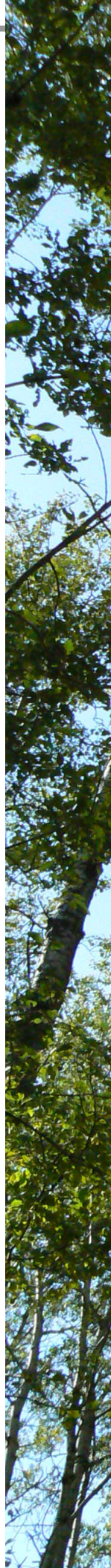
Weyerhaeuser Company, Alberta Forestlands	Greg Behuniak (780) 539-8207 Wendy Crosina (780) 451-9783	Greg.Behuniak@weyerhaeuser.com Wendy.Crosina@weyerhaeuser.com
Wood Fibre Centre, Canadian Forest Service, Natural Resources Canada	Dan MacIsaac (780) 435-7332 Derek Sidders (780) 435-7355	Dan.MacIsaac@NRCan-RNCan.gc.ca Derek.Sidders@NRCan-RNCan.gc.ca



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www.ales.ualberta.ca/rr/Research/WESBOGY.aspx

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