Company Company	Contact Email Address Contact Email Address	Name Name	Title Title	Description Description	Start Date (YYYY- Start Date (YYYY-	Completed Date (Y Completed Date (Y	Investigator Investigator	Objective Objective	Installation Da Installation Da	Installation Date D Installation Date D	Results Results	Implications Implications	Limitations Limitations	Barriers To Application Barriers To Application	Policy Impact Policy Impact	Funding Source Funding Source	Lead Organization Lead Organization	Species Species	Location Location
FGROW (PGYI)	sharon@sugarloafconsulting.ca	Example Projec	Example	Example	2019-01-31	2019-02-28	Example PI	Example Objective	2019-02-28	Example	Example	Example	Example	Example	Example	Example	Example	Example	Example
University of Alberta	phil.comeau@ales.ualberta.ca		Evaluation of banding as an alternative for establishing mixedwood stands Progress to February 2015	At each location, we selected the most successful (i.e.higher growth) mechanical site preparation treatment and a vegetation control treatment (i.e., fire or herbicide) to be compared against the untreated/control. The five experiments each used a randomized complete block	2006-01-01	2009-01-01	Lei Chen et. al.	This long term field experiment was established to test and demonstrate selected options for creating mixtures of aspen and white spruce on recently clearcut mesic sites using combinations of treatments including mounding and banding at different widths and spacing.	2006-01-01	Two sites had site prep and planting in 2006 and first measurement in either 2007 or 2009. Other 3 sites were	Have not finished study, initial results after year 3 provided. To date, treatment effects are highly variable due to effects of site, treatments and treatment timing. Treatments have not had a significant effect on plot level averages of spruce height at the end of the third growing	these studies will be useful in evaluating and refining alternative approaches for creating and managing mixedwood stands. Patch treatments may offer a less expensive alternative for creating mixedwood	Other studies have indicated that high variability should be expected in regard to species response to climate change based on their geographic			Funding for work through 2012 was provided by the Mixedwood Management Association of Alberta. Funding for work in	University of Alberta	white spruce and aspen	Snake Mtn (Weyerhaeuser), LacLaBiche (ALPAC), Fawcett Lk (Vanderwell), Driftpile (Westfraser), Sulphur Lk (DMI)
University of Alberta	phil.comeau@ales.ualberta.ca		Drought explains variation in the radial growth of white spruce in western Canada	The database included tree data (e.g. species, dbh, height, dead/ alive status) for a total of 11,673 PSPs established and measured between 1931 and 2015. The total number of trees was 1,250,257 and the total number of observations equaled 2,572,122. Historical climate data was generated using ClimateNA v5.10 and nine candidate variables were selected, including: mean annual temperature, mean warmest month temperature, mean coldest month temperature, mean annual precipitation, mean summer precipitation, growing degree-days above 5, summer heat-moisture index, annual heat-moisture index, and Climate Moisture Index	2015-01-01?		Lei Chen et. al.	In this study, we used a network of ring-width chronologies from 40 white spruce sites along a wide lat-itudinal gradients from 52◦N to 58◦N in Alberta, Canada and attempted to understand the complicated response of tree growth to climatic variables and to identify the main limiting factor for the radial growth of white spruce.			The linear statistical methods indi-cated that the previous summer temperature imposed a strong negative impact on the radial growthof white spruce while the precipitation and climate moisture index in prior and current summer bothhad significant positive effects on the radial growth. Similarly, the VS-Lite model showed that the radialgrowth of white spruce was limited by soil moisture. This suggests that temperature-induced drought isthe main limiting factor for the radial growth of white spruce. Furthermore, climate-growth relationshipvaried along different elevations, latitudes, and growing degree days (GDD >5◦C). The radial growth ofwhite spruce in northern stands was often more strongly limited by temperature-induced drought dueto the higher temperature and lower precipitation.	Response of white spruce to climate change induced drought	Study did not account for differences in soils or soil drainage and possible insect damage or diseases. The study also recognized that different measurement protocols were applied by each organization.		Effect of global climate change on growth of white spruce in Alberta, Canada	Natural Science and Engineering Research Council of Canada, Mixedwood Management Association, and Forest Resource Improvement Association of Alberta, and other international scholarship funds.	University of Alberta	White Spruce	Mixedwood Forest in Alberta - latitudinal gradient of 52◦N to 58◦N
University of Alberta	phil.comeau@ales.ualberta.ca		Contributions of insects and droughts to growth decline of trembling aspen mixed boreal forest of western Canada	In this study, we combined tree-ring width and basal area increment series from 40 trembling aspen (Populus tremuloides Michx.) sites along a latitudinal gradient (from 52° to 58° N) in western Canada and attempted to investigate the effect of drought and insect outbreaks on growth decline, and simultaneously partition and quantify their relative contributions.	2010-01-01	2011-10-01	Lei Chen et. al.	The goals of this work were to (1) determine the effect of insect outbreaks on growth decline, (2) investigate whether insect outbreaks were triggered by drought, and (3) quantify the relative contribution of droughts and insects to forest decline.		Tree ring and climate data were collected from 1930-2010.	Results indicated that the influence of drought on forest decline was stronger than insect outbreaks although both had significant effects. Furthermore, the influence of drought and insect outbreaks showed spatiotemporal variability. In addition, our data suggest that insect outbreaks could be triggered by warmer early spring temperature instead of drought, implicating that potentially increased insect outbreaks are expected with continued warming springs	Understanding the effects of drought and insect disturbances, alone and in combination, will help managers predict the responses of aspen ecosystems to climate change.			Effect of climate change (specifically drought) on viability of aspen stands in Alberta	Natural Science and Engineering Research Council of Canada, Mixedwood Management Association, and Forest Resource Improvement Association of Alberta, and other international scholarship funds.	Univesity of Alberta	Trembling Aspen	Mixedwood Forest - latitudinal gradient from 52° to 58° N in western Canada
University of Alberta	phil.comeau@ales.ualberta.ca		Evaluation of competitive effects of tall shrubs on white spruce and lodgepole pine in Northern Alberta	The effects of shrubs, herbs and other trees on nutrient and light availability and growth of white spruce and lodgepole pine were examined.	2006-01-01	2006-12-30	Francesco Cortini	Examine effects of tall shrubs on light, nutrient availability and on growth of lodgepole pine and white spruce.			Models are presented which can be useful in estimating effects of competitors on the growth of lodgepole pine and white spruce. Tall shrub, tree and herbaceous cover all exert influences on the growth of white spruce. However, for lodgepole pine results indicate that tall shrubs are the major competitors.	Our study suggests that the current Alberta regeneration standards may be overestimating the effect that competing vegetation has on conifer growth since significant growth reduction occurs only at high shrub densities.			The current Alberta regeneration standards may be overestimating the effect that competing vegetation has on conifer growth since significant growth reduction occurs only at high shrub densities.	Canadian Forest Products Ltd. (CANFOR), and Weyerhaeuser Co. Ltd	University of Alberta	White Spruce and Lodgepole Pine	South of Grande Prairie, Alberta
University of Alberta	phil.comeau@ales.ualberta.ca		Trembling aspen competition and climate effects on white spruce growth in boreal mixtures of Western Canada	Spruce and aspen have been measured regularly since establishment of the WESBOGY Long Term Study. To avoid confounding results with undocumented competitive effects or initial responses to aspen thinning, we utilized data starting two years after thinning treatments. For this analysis we used data for the period from 1997 to 2006. For ALP, DMI, and SRD there are four current annual increments available; for SBR, SPA, and WFR there are five current annual increments available; and for WGP there are six current annual increments available over this time period.	2012-01-01	2012-12-30	Francesco Cortini	We investigated Trembling aspen competition and climate effects on white spruce growth in boreal mixtures of Western Canada		Used data from 1997-2006	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)spruce growth increases by only 8%.	Abundant aspen competition limits the spruce responses to rising temperature, presumably due to competition for light and potentially increased competition for soil resources.			Effect of gloabal climate change and the relative impact of increasing temperatures on aspen vs white spruce growth	We are grateful to the Western Boreal Growth and Yield Association (WESBOGY) for providing the data used in this study.	University of Alberta	White Spruce and Trembling Aspen	Data for this study comes from field installations established by the Western Boreal Growth and Yield Association (WESBOGY) for a long term study of growth and development of tended mixtures of white spruce and trembling aspen (Bokalo et al., 2007). The installations include: the Alberta-Pacific Forest Industries Inc. (ALP) installation located near Boyle, Alberta; the Daishowa-Marubeni (DMI) installations located near Peace River, Alberta; the Weyerhaeuser Saskatchewan Division (SBR and SPA) installations located near Big River and Prince Albert, Saskatchewan; the Alberta Sustainable Resource Development (SRD) installation located near Smith, Alberta; the Westfraser (WFR) installations located near Hinton, Alberta; and the Weyerhaeuser Grande Prairie (WGP) installations located near Grande Prairie, Alberta
University of Alberta	phil.comeau@ales.ualberta.ca		Effects of climate on growth of lodgepole pine and white spruce following site preparation and its implications in a changing climate	At each location, we selected the most successful (i.e., higher growth) mechanical site preparation treatment and a vegetation control treatment (i.e., fire or herbicide) to be compared against the untreated/control. The five experiments each used a randomized complete block design in which each treatment was replicated four times (Tanli and Wonowon) or five times (Bednesti, Inga Lake, and Iron Creek). One exception is the breaking plow treatment at Iron Creek, which was only replicated twice. A minimum of 48 trees were planted in each plot. Trees were measured regularly for diameter and height over the studied 20-year period (1987–2006) and each site was measured 16 times at Bednesti, Iron Creek, and Wonowon, 18 times at Tanli, and 19 times at Inga Lake.	?	?	Francesco Cortini	In this study, we explored growth of lodgepole pine and white spruce in relation to climate and site preparation using 20 years of data collected from studies in British Columbia		Used data from 1987-2006	Results indicate that up to 45% of the variation in spruce growth and up to 37% of the variation in pine growth over this 20-year period can be explained by selected climatic variables. Monthly climate variables showed a stronger relationship to conifer growth than seasonal and annual variables. Climate variables related to the preceding year accounted for more than half of the variables in the final equations, indicating a lagged response in conifer growth. Future projections indicated that height growth of young lodgepole pine plantations in the subboreal zone could benefit (in the short term) from longer growing seasons by up to 12% on untreated stands. Untreated young white spruce plantations in the boreal zone may suffer height growth decreases of up to 10% due to increased drought stress. Vegetation control and mechanical site preparation treatments appear to mitigate effects of climate change to some extent.	For the sub-boreal zone of British Columbia (Canada), young lodgepole pine plantations will potentially benefit in the short term from longer growing seasons as a result of global warming. The untreated plots are showing greater potential in relative growth increase and smaller increases can be observed for the mechanical site preparation treatment and the vegetation control treatment. For the boreal zone of British Columbia, young white spruce plantations may suffer from drought stress as the climate warms. Potentially, there will be more negative effects on untreated stands, while vegetation management and mechanical preparation might be beneficial for white spruce growth in the short term.			Results indicate that future growth of lodgepole pine in the sub-boreal spruce zone of British Columbia might benefit from the future climate conditions in plantations up to 20 years old. For the boreal zone of British Columbia, young white spruce plantations may suffer from drought stress as the climate warms.	Funding for this project was provided by the "Forests for Tomorrow" program within the Forest Practices Branch of the BC Ministry of Forests and Range.	University of Alberta	Lodgepole Pine and White Spruce	Data for lodgepole pine came from two long-term study sites in British Columbia. The Bednesti site (53852'N, 123829'W; elevation 850 m) is located west of Prince George, British Columbia, in the Stuart Dry Warm variant of the Sub-Boreal Spruce zone (SBSdw3) and the Tanli site (53817'N, 124828'W; elevation 1240 m) is located south of Vanderhoof, British Columbia, in the Babine Moist Cold variant of the Sub-Boreal Spruce zone (SBSmc2) Data used for white spruce were obtained from three sites in British Columbia: Inga Lake (56837'N, 121838'W; elevation 890 m), Iron Creek (56838'N, 122819'W; elevation 820 m), and Wonowon (56837'N, 121849'W; elevation 900 m). These three sites are located north of Fort St. John, British Columbia, in the Peace variant of the moist warm subzone of the Boreal White and Black Spruce zone (BWBSmw1)

University of Alberta	phil.comeau@ales.ualberta.ca		Survival functions for boreal tree species in northwestern North America	The database included tree data (e.g. species, dbh, height, dead/ alive status) for a total of 11,673 PSPs established and measured between 1931 and 2015. The total number of trees was 1,250,257 and the total number of observations equaled 2,572,122. Historical climate data was generated using ClimateNA v5.10 (Warg et al., 2012) and nine candidate variables were selected, including: mean annual temperature (MAT, ˚C), mean warmest month temperature (MWMT, ˚C), mean coldest month temperature (MCMT, ˚C), mean annual precipitation (MAP, mm), mean summer precipitation (MSP, mm), growing degree-days above 5 ˚C (DD5), summer heat-moisture index (i.e. SHM = (MWMT + 10)/(MSP/1000)), annual heat-moisture index (i.e. AHM = (MAT + 10)/(MAP/1000)), and Climate Moisture Index	?	?	Francesco Cortini	The objective of this study was to develop improved models of survival probability for white/Engelmann spruce (Picea glauca (Moench) Voss/Picea engelmannii Parry ex Engelm.), black spruce (Picea mariana (Mill.) BSP.), lodgepole pine (Pinus contorta Douglas ex Loudon), jack pine (Pinus banksiana Lamb.), trembling aspen, balsam poplar, and balsam fir (Abies balsamea (L.) Mill.) based on data from an extensive network of permanent sample plots in northwestern North America.	Data included measurements between 1931 and 2015	Survival increased nonlinearly with tree size and the effect of competition on tree survival was related to the shade-tolerance of the species and to stand composition, with shade intolerant conifer species (i.e. lodgepole and jack pine) being more negatively affected by competition compared to shade intolerant deciduous species (trembling aspen and balsam poplar) and shade tolerant spruce species (white and black spruce). Competition from larger spruce (Picea spp.), fir (Abies spp.) and deciduous species (e.g. Populus spp. and Betula spp.) had stronger influences on survival than pine species (Pinus spp.). Intraspecific competition also had significant effects on survival of the majority of the species. Climate Moisture Index provided better results than other climate variables for most species and survival probability increased with increasing values of CMI (i.e.relatively cooler and wetter climate), while for pine species survival probability decreased with increasing CMI and showed higher levels of survival on warmer and drier sites for the range of conditions included in our data.	The models developed in this study contribute to our understanding of factors influencing survival probability of these nine species and could be used to improve the predictive ability of existing models such as the Mixedwood Growth Model						
Hinton Wood Products	Hinton Enhanced Forest Management Program Trial Summaries and Program Direction	Commercial Thinning Trial #2 (McCardell Creek)	Trial was established in a 57 yr old fire-origin lodgepole pine stand in McLeod 4. Twelve fixed area treatment plots were estalished in a randomized block design consisting of three replicates of the following 4 treatments: control (unthinned) and 1600, 2000 and 2400 trees per hectare (post-thinning densities). One mensuration plot was placed in each treatment plot. mensuration plot sizes were varied based on expectinging densities and in order for	1998-02-01	Mar-03	Silfor Consulting and several other consulting companies	1) Determine the criteria and thresholds of stand and tree characteristics that control the stand's growth response after thinning and it's suitability for commercial thinning. 2) Determine the effects of different thinning intensities on growth response and stand recovery after thinning. 3) evaluate implications of responses to volume production at various utilization standards. 4) Evaluate implications of responses for wood and fiber produciton 5) Facilitate economic evaluation of the thinning treatments 6) Assess impacts of thinning on stand health and	Feb-98	Thinning positively affected DBH increment in all spacings, despite an anomalous result in block 1 of the 2400 treatments. Height increment results were variable and inconclusive. This may in part be because only every fifth tree was measured for height at the time of establishement and fifth year re-measurement.	In 2004, the incremental costs for commercial thinning were $18.20/m3. This number has likely changed and a better estimate could be obtained from recent operational commercial thinning. There have historically been difficulties in finding qualified contractors. The new utilization standard may make commercial thinning infeasible.	The height issue makes it difficult to get an accurate picture of volume response. This may be better evaluated after the next measurement, where there will be height measurements for all the trees.		FRIAA	Hinton Forest Products	Lodgepole Pine	McLeod 4, Hinton Alberta
University of Alberta	phil.comeau@ales.ualberta.ca		Competitive interactions between aspen and white spruce vary with stand age in boreal mixedwoods	The study used a neighbourhood approach to examine competition across an age sequence of mixedwood stands. Nine stands were located on similar ecosites, three for each of the three age classes considered (class 1: 10–20 years, class 2: 20–40 years and class 3: 40–60 years). Several competition indices based on	2003-01-01	Jan-05	Cosmin N. Filipescu	Determine the competition effects of aspen on white spruce			Transmittance was poorly predicted by competition indices, except for some indices based on density, with relationships generally explaining less than 40% of variation. Models of spruce growth (diameter and height increment) indicated variable performance among stands and indices	Applying growth–competition relationships across stands of different ages should be done with caution		This project was funded by the Mixedwood Management Association of Alberta.	University of Alberta	Aspen and White Spruce	Southeastern area of Boreal Mixedwood ecological subregion of Alberta - specific lat/long loations available in paper
University of Alberta	phil.comeau@ales.ualberta.ca		Aspen competition affects light and white spruce growth across several boreal sites in Western Canada	Competition indices based on density (number of trees, basal area, and spacing factor), distance dependent and independent size ration (Heygi's and Lorimer's) and crown characteristics (crown volumen, surface area and cross-sectional area) of apsen were tested.	2002-05-01	Sep-03	Cosmin N. Filipescu	Examine the effectiveness of competition indices for predicting light transmittance and white spruce growth across trembling aspen density gradients using sites from a long-term study of mixed wood growth and development in Alberta and Saskatchewan.			Distance independent indices (basal area and Lorimer's) work as well or better than distance -dependent indices for characterizing trembling aspen competition with white spruce in young mixed wood boreal stands in Western Canada	Relationships between aspen competition and either light or spruce growth vary from site to site, making region specific calibrations of these relationships necessary.		NSERC of Canada Collaborative Research and Development Grant	University of Alberta	Aspen and White Spruce	Study sites used were those established by the Western Boreal Growth and Yield Association (WESBOGY) for a long term study of growth and development of tended mixtures of white spruce and trembling aspen. Specific sites for this study were on the oldest blocks from Peace River, Grande Prairie, Edson and Prince Alberta. Lat/long locations are specified in paper.
University of Alberta	phil.comeau@ales.ualberta.ca		Infuence of Populus tremuloides on density on air and soil temperature.	Monitored temperature for 3 growing seasons in young mixedwood stands of variable density at two boreal locations in Alberta, Canada.	2002-01-01	2004-12-30	Cosmin N. Filipescu	Determine the effect of various densities of aspen understory on air and soil temperature.			Maintaining partial aspen cover may provide frost protection to planted white spruce in young boreal mixedwoods	Several practical applications are suggsted for management of boreal mixed wood forests to reduce the risk of frost occurrence. 1) selection of planting spots in suitable microsites 2) site preparation treatments that alter	Benefits only apparent where there is an actual risk of frost injury occuring		Funding provided by NSERC and University of Alberta	University of Alberta	Trembling Aspen	Study sites used were those established by the Western Boreal Growth and Yield Association (WESBOGY) for a long term study of growth and development of tended mixtures of white spruce and trembling aspen. Specific sites for this study were
University of Alberta	phil.comeau@ales.ualberta.ca		Modelling Growth-Competition Relationships in Trembling Aspen and White Spruce Mixed Boreal Forests of Western Canada	We combined traditional approaches of collecting competition data with dendrochronology to provide retrospective measurements of stem diameter growth. Several competition indices including stand basal area (BA), the sum of stem diameter at breast height (SDBH), and density (N) for the broadleaf and coniferous species, as well as similar indices considering only trees with diameters greater than each subject (BAGR, SDBHGR, and NGR), were evaluated.	2007-01-01	2011-12-31	Jian-Guo Huang	We used tree ring analysis as a substitute for permanent sample plots to obtain data for quantifying the effect of inter- and intra-species competition on stem growth of the two predominant species, white spruce and trembling aspen in the boreal mixedwood forest of western Canada.	Field sampling was completed in 2007, 2008, 2010 and 2011.	Through a nonlinear mixed modeling approach, we established a powerful model to predict basal area growth as the function of the growth of dominant trees, the difference in size between the nearby dominant trees and of subject trees, deciduous and coniferous competition levels, and ecoregions. We found the competition index using the sum of diameter at breast height of thicker trees is a reasonable and ecologically meaningful predictor for predicting aspen and white spruce growth, though other indices also fit well.	We found the competition index using the sum of diameter at breast height of thicker trees is a reasonable and ecologically meaningful predictor for predicting aspen and white spruce growth, though other indices also fit well.			University of Alberta	Trembling aspen and white spruce	Our study area included the mixedwood ecoregions in Alberta, Canada, which occupy 75% of the forested area of the province. Our sampling covered most of these regions, from Rocky Mountain House in the south to High Level in the north, and east from Fort McMurray to Fairview and Hinton in the west (Fig. 1). Sampling locations were distributed throughout the Central Mixedwood, Dry Mixedwood, Lower Foothills, and Lower Boreal Highlands ecoregions
University of Alberta	phil.comeau@ales.ualberta.ca		Creating boreal mixedwoods by planting spruce under aspen: successful establishment in uncertain future climates	Treatments included thinning from 6000 stems/ha to 3000, 2000 and 1000 stems/ha and fertilization	1991-01-01	2015-12-31	Richard Kabzems	Examined the growth of white spruce during the first 18 years after being planted beneath a 39 yr old stand of trembling aspen	Original plots were established in 1991 and 1993. Regular measurements taken between establishment and 2015	Initial stimulation of understory vegetation by fertilizer had no meanuable effect on spruce heights or diameters at year 18. Aspen thinning treatments did not have a significant effect on spurce height growth rates after after spurce crowns had emerged above the understory shrub layer due to rapid aspen basal area increases after thinning. Small but significant increases for spruce height and diameter were present in the 1000 and 2000 stems/ha aspen thinning.	A much wider range of aspen stand conditions may be suitable for planting spruce to create mixedwood ecosystems than has been previously considered.		The moderated environment under aspen is likely to become increasiingly advantageous if more frequent and sustained drought episodes are a critical feature of future climates.	BC Minsitry of Forests, Land and Natural Resource Operatios	University of Alberta	White spruce and aspen	Two sites near Fort Nelson, BC (Sierra Road) and Dawson Creek, BC
University of Alberta	phil.comeau@ales.ualberta.ca		Managed Mixtures of Aspen and White Spruce 21 to 25 Years after Establishment	We report 21 to 25 year results of managed mixtures on two study sites where the white spruce was planted, and the density of aspen natural regeneration manipulated within five years of the stand initiation disturbance.	1989-01-01	2011-12-31	Richard Kabzems	The objectives of the study were to: (1) test the effects of aspen density on white spruce size and growth, and on aspen growth and size; and (2) examine the potential yield implications for the development of pure and mixed stands.	Established in 1989, Measurements occurred in 1993, 1997, 1999, 2002 and 2010 at Bear Mountain and in 1993, 1996, 1998, 2002 and 2010 at Siphon Creek, Measurement of basal area was done in September of 2011.	On both sites, white spruce mortality did not increase with increasing aspen density. While height and diameter growth of white spruce declined with increasing aspen density, the effect was not entirely consistent across the two sites. Abrasion from aspen branches was the most common source of damage to spruce crowns. Mixed stands had greater merchantable volume production than pure spruce stands based on model projections.	Intimate mixtures of boreal mixedwoods have the greatest potential to maximize tree production and achieve numerous ecological values, but are the most difficult and expensive to achieve operationally. The results of this study provide guidance to encourage development of cost effective silviculture systems for boreal mixedwoods, and indicate that reductions of aspen densities to between 2000 and 5000 stems ha˗1 at or before age 5 are likely to provide the highest merchantable volumes from aspen-white spruce mixedwood stands Understory protection applied to a managed mixedwood stand would create several different types of mixedwood stand structures over the rotation period, maximize stand level productivity for the two species, and enable operational efficiencies.	Intimate mixtures of boreal mixedwoods have the greatest potential to maximize tree production and achieve numerous ecological values, but are the most difficult and expensive to achieve operationally.	Application of aspen harvest at year 60, while protecting the spruce component for a second harvest entry at year 90, was projected to optimize combined yield for the mixedwood stands.	BC Minsitry of Forests, Land and Natural Resource Operatios	University of Alberta	White spruce and trembling aspen	The study was conducted at Siphon Creek (120˚191 W, 56˚271 N) and Bear Mountain (120˚201 W, 55˚391 N) in northeastern British Columbia, 45 km northeast and 72 km southeast of Fort St. John, respectively. Both sites are within the "Moist Warm" variant of the Boreal White and Black Spruce biogeoclimatic zone (BWBSmw; [2]).

University of Alberta	phil.comeau@ales.ualberta.ca	Relationships between forest structure, understorey light and regeneration in complex Douglas-fir dominated stands in south-eastern British Columbia	Measurements were collected 15 years after selection harvesting, which was designed to create four different levels of residual basal area (8 m2/ha, 16 m2/ha, 24 m2/ha and uncut).	1993-01-01	2009-12-31	Kyle D. Lochhead,	Several methods for estimating the understorey light environment in an uneven-aged mixed conifer forest in the Interior Douglas-fir zone of south-eastern British Columbia, Canada are evaluated.	Treatments established in 1993, selection harvesting occurred in 1994 and measurements taken in 2008 and 2009	Understorey light availability was highly variable across all levels of residual basal area with estimates of stand structure, including density (N), basal area (G) and stand density index (SDI) explaining 37.2–52.1% of population level variation. While relatively large trees effectively reduced light levels below 40% open sky at a stand level; intermediate and smaller sized trees were found to have the greatest influence on light attenuation at the micro-site scale. Stand variables that heavily weighted the influence of larger trees on light attenuation were weak predictors of understorey light at the micro-site scale. Incorporating variables describing composition and inequality of tree size increased the predictive power of the models resulting in the ability to explain 55% of the variation in light levels.	Results from our study demonstrate that successful natural regeneration of Douglas-fir and reasonable growth rates are achieved when retained overstorey basal area is reduced to 24 m2/ha or lower. Overstorey residual densities must consider species specific targets, with a greater emphasis on controlling density and basal area of smaller trees in order to establish new regeneration and release small advanced regeneration.	Small plot sizes used in this study are likely limiting the ability to describe variation in light levels and we recommend the use of larger plots (with a radius between 1.0 and 1.7 times tree height) for future studies of this nature.	Funding for this research was provided by the B.C Ministry of Forests and Range Southern Interior Forest Region (Forest Investment Account).	University of Alberta	Douglas Fir	This study was conducted at the St Mary River Research Trial (49°37'01000 N, 115°58'02000W), in the Interior Douglas-Fir dry-mild Kootenay biogeoclimatic variant (IDFdm2 site series 01) which is approximately 25 km northwest from the town of Cranbrook, British Columbia,
University of Alberta	phil.comeau@ales.ualberta.ca	Dynamics of regeneration gaps following harvest of aspen stands	To examine gap dynamics from the pre- to post-harvest period, we mapped changes in spatial coverage (in area and distribution) of gaps over time using a series of air photographs taken 1 year before harvest, and 1, 4 and 12 years after harvest, supplemented by 11-year postharvest orthophotograph imagery (orthorectified and georeferenced, with a resolution of 1 m). We conducted field sampling in a random subsample of the postharvest regeneration gaps that were discernible on air photographs taken 12 years after harvest.	1989-01-01	2004-12-31	Daniel A. MacIsaac,	This study assessed the dynamics of gap development in postharvest regeneration in five stands in northwestern Alberta dominated by trembling aspen	Harvest was done in 1989 and 1990. Study was done in 2004 (14 years postharvest).	The blocks we studied had a combined gap area of up to 29% of stand area 12 years postharvest. Within the 14-year-old postharvest regenerating aspen stands, aspen height varied from 1 to 11 m; this substantial variability appeared to be largely due to the influence of browsing. There was little evidence of ongoing regeneration within postharvest regeneration gaps, indicating that these gaps will probably persist over time.	Our study of withinstand aspen gap dynamics following harvesting illustrates the importance of considering spatial dynamics during the regenerating phase of deciduous forests as a significant consideration in boreal forest management. The spatial heterogeneity resulting from gaps could be advantageous, however, either as part of ecosystem-based management emulating natural disturbance or as a template for mixedwood management, where white spruce (Picea glauca (Moench) Voss) are established in gaps.		Funding was provided by the NCE Sustainable Forest Management Network, Killam Trust Fund, and Natural Resources Canada, Canadian Forest Service.	University of Alberta	Trembling Aspen	Whitemud Hills area, 45 km northwest of Peace River, Alberta (56°36'N, 117°41'W).
University of Alberta	phil.comeau@ales.ualberta.ca	Competitive effects of woody and herbaceous vegetation in a young boreal mixedwood stand	Applied herbicide treatments designed to control only woody or woody and herbaceous vegetation in a mixed wood stand. Examined LAI, light, soil moisture, soil temperature, air temperature, nitrogen availability and spruce growth.	2002-01-01	2005-12-31	Cosmin D, Man	The influence of aspen and herbaceous vegetation on resource availability and growth of white spruce was examined.	Established in 2002, measurements in 2005	Treatments reduced LAI and increaed light, soil nitrogen availability and spruce growth. Soil moisture was not affected in this year. Both the woody and herb-grass layers appear to be competing for light and soil nitrogen in this young plantation. Controlling only woody vegetation resulted in an increase in herbaceous and total LAI.	Spot treatments of herbicide (a 2m radius of complete vegetation control around white spruce seedlings) may be a promising alternative to broadcast herbicide treatments for establishing spruce in mixedwood stands.		Funding was provided by several partner agencies including Blue Ridge Lumber, Miller Western, Canadian Forest Products, Canadian Ecology Centre Forestry Research Parntership, Monsanto Danada, Dow agro-sciences, Alberta Forest Products Association, Alberta Mixedwood Management Association, Ontario Minsitry of Natural Resources and Canadian Forest Services. Financial Support also provided by NSERC.	University of Alberta	Trembling aspen and white spruce	30 km northeast of Whitecourt, Alberta
University of Alberta	phil.comeau@ales.ualberta.ca	Linking the Depth-to-Water Topographic Index to Soil Moisture on Boreal Forest Sites in Alberta		1991-01-01	2013-12-31	Gabriel S. Oltean,	evaluate the relationships between soil attributes and DTW; (depyh tpo water) the optimal flow initiation area; and models to map the spatial variation of soil properties.	Four sites estabished 1991 and 1992, fourth site established in 2003. Sampling done in 2013.	Soil moisture regime (SMR), drainage class, and depth-to-mottles were strongly related with DTW, whereas soil nutrient regime, organic matter thickness, soil texture, and coarse fragment content exhibited weak and inconsistent relationships with DTW. A flow initiation area of 2 ha yielded the best representation for SMR, drainage class, and depth-to-mottles.	These results suggest that the DTW index can capture soil properties closely influenced by the water table but cannot characterize site and soil factors, which are also determined by parent material, climate, and vegetation.	because of the complex interactions between the environmental factors controlling soil formation processes, we support the suggestion of Moore et al. (1993) that it is necessary to take a conservative approach when studying the relationships between soil attributes and topographic indices	No reference to funding	University of Alberta	soils beneath boreal forest sites in Alberta	Soil and site data were collected at five areas located in the Central Mixedwood natural subregion of the boreal forest of northern Alberta (Figure 1; Table 1). Four of these sites are part of a long-term study established between 1991 and 1992 by the Western Boreal Growth and Yield Association (WESBOGY) to study the development of aspen and spruce mixtures (Bokalo et al. 2007), whereas the Judy Creek (JC) research site was established in 2003 to evaluate selected strategies for establishment of intimate mixtures
University of Alberta	phil.comeau@ales.ualberta.ca	Carbon isotope discrimination by Picea glauca and Populus tremuloides is related to the topographic depth to water index and rainfall1	To evaluate whether DTW and carbon isotope discrimination were related and to determine if these relationships are influenced by climate, we sampled three time periods, which differed in the amount of annual precipitation (MAP), from tree cores collected from 42 trembling aspen and 43 white spruce trees growing along DTW gradients at two locations in central Alberta, Canada.		2014-12-31	Gabriel S. Oltean,		Both stands were 23 years old at the time of sampling; the aspen stand had regenerated from root suckers after harvest in the winter of 1990–1991, but it was sampled early in the spring of 2014 before budbreak, whereas the spruce stand had been planted in May 1993 with 1-year-old stock and was sampled in the late summer of 2014.	Increasing MAP led to lower 13C, indicating less drought stress as water availability increases, while 13C increased with DTW up to a threshold value, after which the relationship levelled off, suggesting hat higher DTW values represent stress-inducing soil conditions. DTW and MAP were then combined into models (aspen, R2 = 0.72; spruce, R2 = 0.44) that could be used to delineate drought-prone areas during periods of low MAP. Tree height and diameter were also related to DTW, suggesting a functional relationship between an index capturing soil properties and tree size.	Our results demonstrate the potential to use the DTW index as a measure of site conditions and to predict stand-level responses.		funded by Alberta Agriculture and Forestry.	University of Alberta	Trembling aspen and white spruce	We selected a trembling aspen (Populus tremuloides Michx.) stand located 30 km south of Grande Prairie in the Boreal Mixedwoods ecoregion of Alberta and a white spruce (Picea glauca (Moench) Voss) stand situated 16 km west of Whitecourt on the eastern side of the Foothills ecoregion
University of Alberta	phil.comeau@ales.ualberta.ca	Sixty-year effects of deciduous removal on white spruce height growth and site index in the Western Boreal		1985-01-01	2010-12-31	Diana E. Osika,	In this study, we evaluated the effects of deciduous removal on white spruce height growth potential using stem analysis on typical control spruce grown with deciduous neighbours and spruce that were released from deciduous competition 60 years prior.	White spruce trees in the permanent sample plots (PSPs) at all locations were tagged and mapped at the time of plot establishment (1936) and treatment. All tree species were measured for diameter at breast height (DBH) at establishment in 1985, 2001, and 2010. A subsample of height was measured at establishment and in 1985; all heights were measured in 2001 and 2010.	Due to the late application of the release treatments (at stand ages of 20–60 years), the observed site index of spruce was not affected by treatment. However, height growth in the 50 years following treatment was increased by 2.1 m. We present a height–age model to specifically estimate the change in SI required to achieve the observed height response following late release. The model indicated that the post-release SI estimate of white spruce would need to be on average 4.2mhigher than control SI to track the height response.	The lack of change in height–age curve shape after release (other than this apparent SI increase) supports the use of existing curves for estimation of SI from height–age measurements on juvenile trees in both pure spruce and mixed stands.	Since the sampling area occupied the entire northward buffer, we acknowledge that our selected trees might have been subject to some belowground influence from the surrounding mixedwood matrix.	We thank the Mixedwood Management Association, the Forest Resource Improvement Association of Alberta, and the Natural Sciences and Engineering Research Council of Canada for funding this study under the Collaborative Research and Development Program.	University of Alberta	White Spruce	The experimental areas were established by the Canadian Forest Service as two studies, MS-8 and MS-153. MS-8 was established in 1936 in a stand south of Singoosh Lake (51.600=N, 100.749=W) with 50 year old white spruce (stump age) in the Duck Mountain (DM) Forest Reserve in Manitoba. MS-153 was established from 1951 to 1954 in 20 to 60 year old (aspen age) stands at Big River (BR) (54.083=N, 107.338=W), BR Nursery, Montreal Lake, Candle Lake (CL) (two blocks) (53.721N, 105.254W), Bertwell, and Reserve (RE) (52.378=N, 102.63=W) in Saskatchewan and at Riding Mountain (RM) (two blocks) (50.690=N, 99.105=W) in western Manitoba. All stands are near the southern edge of the Boreal Plains ecozone,

University of Alberta	phil.comeau@ales.ualberta.ca		Effects of opening size and stand characteristics on light transmittance and temperature under young trembling aspen stands	The effect of opening radius on light levels was examined in nine young aspen dominated stands in each of two areas:	2002-01-01	2002-12-31	Janet M. Pritchard	The two main objectives of this study were: (1) to determine how light transmittance is influenced by gap size and pre-treatment transmittance levels and; (2) to determine how the occurrence of cold temperatures is influenced by gap size and the height and density of the stand in which the openings were created.	2002	Results indicated a strong relationship between light levels and opening size after considering pretreatment light levels. The relationship between opening size and temperature was weak with minimum temperatures being more affected by the height and density of the surrounding stand than opening size.	Circular openings can be a useful management tool to promote the earlier growth and vigour of white spruce in young mixedwood stands.		no fundng source identif	University of Alberta	Tremblig Aspen and White Spruce	the first area was located northeast of Slave Lake, Alberta (558 300 N, 1148 300 W); and the second area was located near Fort St. John in northeastern B.C. (568 N, 1208 300 W)
University of Alberta	phil.comeau@ales.ualberta.ca		Effects of aerial pulse spraying on mixedwood stand structure and tree growth	The study evaluates the effect of patches 12 m in width and 6, 9, 12 and 18 m in length created using aerial application of glyphosate herbicide in a 12 years old stand (planted in 1996; harvested in 1994/1995 or 1995/1996) located approximately 80 km northeast of High Level Alberta.	2006-01-01	2010-12-31	Phil Comeau	Data were collected to answer the following questions: 1. What is the overall effect of these patch treatments on coverage of the blocks by spruce and aspen dominated areas? 2. How is spruce performing in the treated and in the untreated portions of the blocks, and in completely untreated blocks? 3. How does patch size influence performance of the spruce within treated areas? 4. Is spruce growth in the untreated ground influenced by the treated bands? 5. When using glyphosate herbicide, is there any effect of the width of untreated patches and bands on the vigour of the residual aspen?	Plots located in June 2006 and treated in 2007.Measurements in 2008, 2009 and 2010.	Spruce in treated patches were significantly larger and have grown more since treatment than those in either the untreated patches or in completely untreated plots. Aspen in untreated patches for all treatment sizes remain unaffected by treatment. Simulations using MGM indicate an opportunity for the pulse spray treatments with 12 m x 18 m treatment patches to increase spruce and aspen yield when each species is utilized at its culmination age by 13% (aspen), 100% (spruce) and 50% (total) above yields provided by the untreated.	This study clearly demonstrated the potential to use the pulse spray system to create patchy (ie. horizontally structured) mixedwood stands, and to enhance spruce growth in these stands.		We gratefully acknowledge funding provided by Tolko Industries and the Forest Resource Improvement Association of Alberta (FRIAA) for this project.	University of Alberta	White Spruce and Trembling Aspen	These 24 plots are distributed in 6 cutblocks in license F8-L14 (N58.68°, W116.73°, Fig. 12) located in proximity to each other.
University of Alberta	phil.comeau@ales.ualberta.ca		Survival probability of white spruce and trembling aspen in boreal pure and mixed stands experiencing self-thinning		2013-01-01	2013-12-31	Valentin Reyes-Hernánde	To anakize the survival probability of trembling aspen (Populus tremuloides Michx.) and white spruce (Picea glauca (Moench) Voss.) trees and saplings, growing in pure and mixed stands experiencing self-thinning, in the Boreal Forest Natural Region of Alberta, Canada.	2013?	Tree growth rate and absolute size of individuals are the most important individual characteristics that define the probability of survival of trembling aspen and white spruce trees and saplings in self-thinning stands in boreal mixedwoods in Alberta.			We gratefully acknowledge support for this research provided by Alberta Environment and Sustainable Resource Development, Alberta Pacific Forest Industries and Weyerhaeuser Canada (access to data sets). VRH acknowledges the Consejo Nacional de Ciencia y Tecnologia (CONACYT) and the Colegio de Postgraduados-Mexico for providing support for his doctoral studies. Additional support was also provided by the Sustainable Forest Management Network, Canada.	University of Alberta	White Spruce and Trembling Aspen	This study was completed using long-term data from permanent sample plots (PSPs) established in pure and mixed stands of trembling aspen and white spruce, located in the Boreal Forest Natural Region of Alberta, Canada.Our study included PSPs located mainly in the Central Mixedwood, the Dry Mixedwood, and the Northern mixedwood Ecological Subregions (Beckingham and Archibald, 1996). The PSPs are located in stands
University of Alberta	phil.comeau@ales.ualberta.ca		The Influence of Stocking and Stand Composition on Productivity of Boreal Trembling Aspen-White Spruce Stands	we examine the individual and combined productivity (periodic annual increment in volume per unit area) of white spruce (Sw) and trembling aspen (Aw) when growing in pure and mixed stands, in mid-rotation and mature boreal unmanaged forests in Alberta, Canada.	published in 2015		Valentin Reyes-Hernández	The objectives of this research were: (1) to evaluate the usefulness of selected stand attributes such as tree density, totalstand basal area, basal area of deciduous species (mainly trembling aspen), and basal area of white spruce, in explaining white spruce, trembling aspen, and total stand periodic annual increment in volume (PAIV); (2) to examine the effects of stand composition (percent of basal area in deciduous species and percent of basal area of		Results indicated a positive effect of both density of deciduous trees and of the percentage of deciduous tree stand basal area on trembling aspen volume PAI. White spruce PAI was positively influenced by spruce and aspen basal area,although effects of aspen were small. Height of both aspen and spruce	Maximum PAI was achieved in mixed stands when site occupancy of both species was at its maximum, indicating the ecological combining ability of these two species. Variation in maximum stocking densities (i.e., stockability) has a strong influence on increment in these forests and is a		National Council of Science and Technology and international agency for support of graduate student	University of Alberta	White Spruce and Trembling Aspen	This research was conducted using data from long-term permanent sample plots (PSP), established in pure aspen, pure white spruce, and mixed stands of both species in the Boreal Forest Natural Region of Alberta, Canada.
University of Alberta	phil.comeau@ales.ualberta.ca		Static and dynamic maximum size–density relationships for mixed stands of trembling aspen and white spruce stands in western Canada	We examine maximum size–density relationships (MSDR) of pure and mixed stands of trembling aspen (Populus tremuloides Michx.) and white spruce (Picea glauca (Moench) Voss.) in the Boreal Forest Natural Region of Alberta, Canada. Stochastic frontier function regression was used to	published in 2012		Valentin Reyes-Hernández	The main objectives of our study were to: (1) determine both the static and dynamic limits of the MSDR for mixed trembling aspen and white spruce stands based on Reineke's relationship; (2) examine the effect of stand composition, site quality indicators and other site characteristics on both the static and dynamic MSDR thinning lines; (3) determine whether mixed stands can support greater total tree densities		A steeper slope was obtained for the dynamic than for the static thinning line, and both MSDR lines slopes are statistically different from the theoretical value proposed by Reineke (1933). The deciduous component (percent of stand total basal area that is deciduous) has a negative effect on the slope and a	Results suggest that local differences such as site quality and stand composition are important factors in determining maximum size–density relationships for these mixedwoods stands and how individual stands develop and self-thin.		National Council of Science and Technology and international agency for support of graduate student. Additional support was provided by the Sustainable	University of Alberta	Pure and mixed stands of White Spruce and trembling aspen	Data used in this research come from PSPs established in pure aspen, pure white spruce and mixed stands of both species in the Boreal Forest Natural Region of Alberta, Canada and included the Central Mixedwood, the Dry Mixedwood and the Northern Mixedwood ecological sub-regions, as well as few plots from the
University of Alberta	phil.comeau@ales.ualberta.ca		Crown allometry and application of the pipe model theory to white spruce (Picea glauca (Moench) Voss) and aspen (Populus tremuloides Michx.) in the western	White spruce (Picea glauca (Moench) Voss) and aspen (Populus tremuloides Michx.) from unmanaged stands in the boreal forest of Alberta, Canada, were examined for two of the main structural assumptions in the process-based model CROBAS:(i) a constant allometric relationship between foliage mass and crown length and (ii) a	published in 2015		Derek F. Sattler	As a first main objective, we test for constant allometric scaling between Wf and Cl for these two species. We then examine the relationship between Wf and Cl for within-crown sections and contrast them to the relationships seen at the whole-crown level. As a second mainobjective, we test the assumption of a linear relationship between Wf and Ascb, which is derived from pipe model theory. We		Results indicated that for both species, a constantallometric relationship between foliage mass and crown length was maintained at the whole crown level over a period exceeding the peak mean annual increment of each species. Within the crowns of spruce, foliage mass accumulated faster near the tree apex as			NSERC through the support of the ForValueNet Strategic Network	University of Alberta	White Spruce and Trembling Aspen	The sampling of trees used in this study was performed adjacent to permanent sample plots (PSPs), which had previously been installed by Alberta Sustainable Resource Development (ASRD) (2005). All PSPs were situated within unmanaged stands that had been established through natural
University of Alberta	phil.comeau@ales.ualberta.ca		Within-tree patterns of wood stiffness for white spruce (Picea glauca) and trembling aspen (Populus tremuloides)1	Radial patterns of modulus of elasticity (MOE) were examined for white spruce (Picea glauca (Moench) Voss) and trembling aspen (Populus tremuoides Michx.) from 19 mature, uneven-aged stands in the boreal mixedwood region of northern	published in 2013		Derek F. Sattler	The main objectives were to (1) evaluate the relationship between pith-to-bark changes in MOE and cambial ageor distance from pith; (2) develop species-specific models to predict pith-to-bark changes in MOE; and (3) to test the influences of radial growth, relative vertical height, and tree slenderness (tree heiqht/DBH) on MOE.		For both species, cambial age was selected as the best explanatory variable with which to build pith-to-bark models of MOE. For white spruce and trembling aspen, the final nonlinear mixed-effect models indicated that an augmented rate of increase in MOE occurred with			NSERC through the support of the ForValueNet Strategic Network	University of Alberta	White Spruce and Trembling Aspen	A total of 64 white spruce trees from 15 permanent sample plots (PSPs) (Alberta Sustainable Resource Development; ASRD 2005) and 27 trembling aspen trees from 9 PSPs were felled to obtain samples on which to perform the MOE tests.All PSPs were located in the central
University of Alberta	phil.comeau@ales.ualberta.ca		Branch models for white spruce (Picea glauca (Moench) Voss) in naturally regenerated stands	To describe the branching characteristics of white spruce trees (Picea glauca [Moench] Voss) in naturally regenerated, pure and mixed-species stands of the Canadian boreal forest, predictive models were developed for: (1) the number of branches (P5 mm diameter), (2) maximum branch diameter	published in 2014		Derek F. Sattler	The objectives (for white spruce) are to: (1) develop branch models for use in naturally regenerated stands, and (2) examine if species-specific stand-level competition affects white spruce branching traits.		The relative or absolute depth into the crown (m) were significant variables in all the models, reflecting the importance of branch age and diminishing light levels with increasing crown depth. Increasing social position within a stand, measured by the basal area of larger trees (Bal), was positively related to an increase in	The models here represent an important addition to the tools required to manage stands with wood quality objectives in mind.		NSERC through the support of the ForValueNet Strategic Network	University of Alberta	White Spruce	Branch characteristics were determined for 65 white spruce trees located adjacent to 15 permanent sample plots (PSP). The PSPs, which had been installed by Alberta Sustainable Resource Development (ASRD, 2005), were situated within unmanaged stands that had established through natural regeneration.All stands in
University of Alberta	phil.comeau@ales.ualberta.ca		Microclimatic and spruce growth gradients adjacent to young aspen stands	In this paper we examine, how young (11–13 year old) aspen (Populus tremuloides Michx) patches influence microclimatic conditions in adjacent openings and how these are reflected in the growth of white spruce (Picea glauca [Moench] Voss) on three boreal mixedwood sites in west-central Alberta, Canada.	2003-01-01	2003-12-31	Mihai F. Voicu,	This study was designed to examine the effects of distance and direction from adjacent aspen stand edges on: (1) light levels (in terms of transmittance); (2) soil moisture; (3) frequency of summer frost events; (4) air temperature; (5) soil temperature. In addition we examine how, growth of white spruce (in terms of diameter, height, stem volume increment, and height allocation ratio) is related to light levels (or		Light levels increased continuously across the aspen stand boundary and reached maximum levels within the opening, while soil moisture was highest near the edge of the opening and then decreased with distance into the aspen stand or into the adjacent opening north of the aspen stand. Light levels were	Results from this study indicate that the negative effects of shading by young aspen on spruce growth are restricted to a narrow band adjacent to the aspen patch equal to 0.3 times the actual height of the aspen while reduction in frost occurrence by the aspen diminishes rapidly with distance from the aspen		Funding for this project was provided by an NSERC Collaborative Research and Development Grant.. Personal financial support for Mihai Voicu was provided by an NSERC graduate	University of Alberta	White Spruce and Trembling Aspen	Field studies were conducted at selected Long-Term Study (LTS) field installations established by the Western Boreal Growth and Yield (WESBOGY) Association (Titus and Wang, 2000). The study was carried out during 2003 at three installations located: (a) south of Grande Prairie, Alberta (548550N,
University of Alberta	phil.comeau@ales.ualberta.ca		Effects of gap size and surrounding trees on light patterns and aspen branch growth in the Western Boreal Forest	Vertical and horizontal patterns of light within gaps and expansion of trees into gaps were examined in young stands dominated by trembling aspen in northeastern British Columbia and northwestern Alberta.	published in 2009		Fang Ye	The objectives were to: 1) quantify the horizontal and vertical light patterns in gaps in relation to location within gaps, surrounding canopy height and gap size, 2) examine the lateral branch and height growth of gap edge trees and 3) investigate how lateral branch growth and height growth can potentially influence the light available in gaps.		Lateral growth of branches of aspen edge trees averaged 15.2 cm/year and was similar to crown expansion rates reported for edge trees in eastern North America. Branches growing into gapes were sinificantly longer then those growing away from gaps and are likely to lead to			BC Ministry of Forests and Range Forest Practices Branch and by the Western Broeal Growth and Yield Association	University of Alberta	Trembling Aspen	The study used data collected from 54 artifically created gaps previously established in seven closed canopy stands growing on mesic sites located in northeastern British Columbia near Fort St. John and from 18 natural gaps in a young stand south of Grand Prairie, Alberta.
Hinton Wood Products		Hinton Enhanced Forest Management Program Trial Summaries and Program Direction	Lynx Creek Research Trial	Trial was established in a 31 yr old fire-origin lodgepole pine stand. It tested three thinning treatments (strip thinning, strip thinning with feathering and an untreated control) and two fertilization treatments. The thinning treatments represented 30% and 50% basal area removals on an area basis. Fertilization involved the addition of 400 kg of nitrogen and 3 kg of boron per hectare	2000-03-01	2003-02-01	Silfor Consulting and several other consulting companies	1) Evaluate utilization and economical parameters of thinning of lodgepole pine, 2) Assess growth and yield response of two thinning types both employing mechanical harvesting methods, 3) assess growth and yield response to nitrogen fertilization in unthinned and thinned treatments, 4) monitor stand development over time in the unthinned stand as compared to those affected ny various treatments		Foliag response one year after fertilization showed that N uptake was not affected by thinning. The greatest response was observed in the strip thinning and feathering treatment. Fertilizer had a positive effect on dbh and gross basal area increment. Fertilizer increased biomass of shrubs and herbs and decreased biomass of moss.	The incremental cost of commercial thinning was approx. $18.20/m^3 in 2004. This number may have changed due to increases in fuel costs and labour market pressures.	There may be diffculties in finding qualified contractors and suitable locations on roaded portions of the landbase. The majority of volume cannot be expected to meet new 15/10	Strip thinning is unlikely to result in as high a growth response as uniform low thinning. The presription was designed assuming a 10/8 utilization, so would not be suitable to use with 15/10	FRIAA	Hinton Forest Products	Lodgepole Pine	Marlboro 24, Hinton, Alberta
Hinton Wood Products		Hinton Enhanced Forest Management Program Trial Summaries and Program	Factorial Thinning and Fertilization Trial	The trial is a 2 by 6 factorial experiment designed as a split plot in a randomized complete block design. The first factor (thinning) occurs at two levels, and the second factor (fertilization treatment) occurs at 6 levels after the first factor has been implemented	2000-04-01	2004-01-31	Silfor Consulting and several other consulting companies	1) Assess the effect of thinning and fertilization, singly or in combination on growth and stand development, 2) determone the optimum fertilization prescription for lodgepole pine applicable to this and similar sites.3) examine the utility of 1st year foliar response (needle weight and nutrient concentrations) as predictors of growth response		Based on the fourth year measurement results, relative increases in merchantable basal area and volume increment attributable to fertilization averaged over 30% and in the best fertilization and thinning combination exceeded 80%. Cross diameter and net basal area	Fertilizer incremental cost was estimated at approx. $13.50/m^3 or $400 per hectare in 2004. This estimated cost is likely low based on recent increases in fuel and labour costs. The incremental cost of commercial recovery is necessary.	Some evidence that disease occurrence was higher (>50%) in thinned stands but this may be a measurement bias.	Fertilizer was hand applied on all trials. Details of an operational program has never been worked out. Helicopter may be a more efficient option	FRIAA	Hinton Forest Products	Lodgepole Pine	McLeod 18, Hinton, Alberta
Hinton Wood Products		Hinton Enhanced Forest Management Program Trial Summaries	McLeod 20 Riparian Trials	The group selection trial intent was to create an inverse J age class distribution. The first of a number of cuttings required to produce this condition was carried out. Basal area was reduced from 42 to 25 by removing "surplus" trees from all diameter	1997-12-31		Silfor Consulting and several other consulting companies	1) Design and test alternative silvicultural systems applicable to riparian zone ecosystems, 2) develop methodology for, and implementation of, a monitoring structure for assessing the effects of silvicultural systems on: natural regeneration establishment and growth, growth response of	Group selection established in winter 1997-98. shelterwood established in March 1999.	There are no remeasurements to report on. The FERIC report on time and motion studies was not found.	Need to assess utility for operational use and importance of haing riparian areas in the contributing landbase.	Not intended to be research trials. No replication and no controls.	No results	FRIAA	Hinton Forest Products	Mixed Wood Forest	McLeod 20, Hinton, Alberta

Hinton Wood Products		Hinton Enhanced Forest Management Program Trial Summaries and Program Direction	Accelerated Stand Development Trial (1997)	Eleven locations were selected along a landscape transect formed by a seismic line which crossed variable topography in the Gregg burn. Locations included stands on variable topographic positions, influencing moisture and nutrient availability and giving rise to different lodgepole pine densities and different growth rates. A detailed	1997-04-01	2002-04-01	Silfor Consulting and several other consulting companies	1) To test the effects of N fertilizer application, dosages and composition on tree growth and the rate of stand differentiation. 2) To quantify the relationship between site attributes and stand development and identifiable stand attributes.	remeasurement dates - Winter 1999-2000 and spring 2002	One-year post-treatment results from the 1997 installations showed positive responses in foliage dry weight and foliar nutrient concentrations in response to N-addition. Nutrient interpretations identified nitrogen and boron deficiencies as limiting growth factors and sulfur at marginal concentration levels in the tested stands. Threeyear	There is not much area like this remaining on the FMA. The window for using this treatment might be past. However, results may be operationally: applicable to dense post harvest regenerating stands.	Timber supply analysis indicated very low forest level impacts (AAC gain) for this treatment due to the relatively small area of stands in this condition and because there is a limited treatment		FRIAA	Hinton Forest Products	Lodgepole Pine	McLeod 4 (Gregg Burn)
Hinton Wood Products		Hinton Enhanced Forest Management Program Trial Summaries and Program Direction	Accelerated Stand Development Trial (1998)	Sites selected in fall of 1997 were fertilized in the fall of 1998. The fertilizer prescription was 400 kg/ha of Nitrogen (urea) and 3 kg/ha of boron. Fertilizer was applied by hand.At each location, an area approximately 50m x 50m was delineated and one 10 x 10 m mensuration plot was established in the center. In these	1998-09-01	2004-04-01	Silfor Consulting and several other consulting companies	The primary objective was to determine the effect of nitrogen fertilizer application on the development and differentiation of dense fire origin lodgepole pine stands.	remeasurement dates - spring 2004	One-year post-treatment assessments in the 1998 installations showed positive increases in needle dry weight and N-concentrations in all nine fertilized stands. First year foliar weight was the best predictor of response based on first year foliar analysis, but less variability in response was explained than in 1997	Costs would be similar to treating mature stands, if application method is the same. Fertilizer incremental cost was estimated at approximately operationally: $13.50/m3 or $400 per hectare in 2004. This estimated cost is likely low based on recent increases in fuel and labour costs.	May have to carry investment for too long to make it worthwhile financially.		FRIAA	Hinton Forest Products	Lodgepole Pine	McLeod 4-Gregg and Mccardell Bums.
Hinton Wood Products		Hinton Enhanced Forest Management Program Trial Summaries and Program Direction	Fertilization of Mid to Late Rotation Lodgepole Pine: Trial #1 Research Experimental	The trial was a randomized complete block design with three blocks and four treatments in each block: urfertilized control, complete fertilizer blend, Nitrogen+ Boron, and Nitrogen only. 20m x 20m measurement plots were contained within 40m x 40m treatment plots. Fertilizer was applied	1998-09-01	2002	Silfor Consulting and several other consulting companies	1) Evaluate effects of three fertilizer treatments on height, diameter and volume growth. 2) Evaluate the interaction of pre-treatment tree and stand characteristics with tree growth response and post-treatment stand development.	remeasurement - 2002	The best response was from the complete blend treatment, with up to twice the volume increment seen in the control. Mean tree height in blend plots is significantly greater than the control or other fertilizer plots. Better response was also seen on poorer sites. Mortality levels are inconclusive; it is	Fertilizer incremental cost was estimated at approximately $13.50/m3 or $400 per hectare in 2004. This estimated cost is likely low based on recent increases in fuel and labour costs. Fertilizer was hand applied on all trials. Details of an operational	Avoid alder and richer sites if designing an operational trial or program.		FRIAA	Hinton Forest Products	Lodgepole Pine	McLeod 5 stand #10
Hinton Wood Products		Hinton Enhanced Forest Management Program Trial Summaries and Program Direction	1998 Fertilization of Mid to Late Rotation Pine-Operational Trials	Five sites were selected for operational pilot trials. They were not designed in randomized blocks. Each stand was divided into several areas of approximately the same size. Fertilization treatments were as much as possible randomly assigned. Each fertilization treatment, including control, had two 20 x 20 m growth monitoring plots	1998-09-01	2002	Silfor Consulting and several other consulting companies	1) Verify the relationship between miniplot results and lodgepole pine radial growth in response to fertilization 2) Evaluate growth response to specific fertilizer treatments 3) Gain experience in operational fertilization and setting up operational trials	remeasurement - 2002	The complete blend fertilizer produced the greatest growth response, supplying up to an additional 12 m3 per hectare relative to controls over the 4-year period. Stands located on sites with poor nutrient status were substantially more responsive than those on medium sites, providing greater consistency and	Incremental cost approximately $13.50/m3 or $400 per hectare. These costs were determined in 2004, and may be low based on recent increases in fuel costs.	Details of operational program have never really been worked out. Helicopter may be a more efficient option but mav be prohibitively expensive.	The trials were not really operational trials, as they were fertilized by hand.	FRIAA	Hinton Forest Products	Lodgepole Pine	McLeod 4, Embarras 6
Hinton Wood Products		Hinton Enhanced Forest Management Program Trial Summaries and Program Direction	2000 Fertilization of Mid to Late Rotation Pine	Selection of stands for the 2000 trials was based upon the one-year foliage results from miniplots established in the candidate stands in 1998. The criteria used for stand selection was a relative needle weight response greater than 30% to at least one of the fertilizers applied, and/or a substantial	2000-01-01	2003	Silfor Consulting and several other consulting companies	Previous fertilizer trials tested a fairly narrow range of compositions. The six research trials established in 2000 were specifically designed to test growth responses to different nutrient additions to determine what treatment would produce the best growth response.		Some stands showed very small or no response. Complete blend fertilizers showed best the response. There was proportionately more growth on black spruce understory in fertilized stands than on the pine. Fertilizer might reduce mortality in older stands. If this is true it	Incremental cost approximately $13.50/m3 or $400 per hectare. These costs were determined in 2004, and may be low based on recent operationally: increases in fuel and labour costs.	This was called an operational trial, but methods used for fertilizer application are not practical for operational implementation. Details		FRIAA	Hinton Forest Products	Lodgepole Pine	Embarras 13 (Stand #1); McLeod 18 (Stand #6); McLeod 23 (Stand #7); Berland 11 (Stand #9); McLeod 4 (Stand # 1 0); McLeod 4 (Stand #11)
Hinton Wood Products		Hinton Enhanced Forest Management Program Trial Summaries and Program Direction	Fertilizer Mini-Plots	The methodology for plots was adopted from the Forest Practices Code (1995) Fertilization Guidebook. Miniplots were established at three times: 1997, 1998 and 2000. The following table outlines the number of plots established in each year, the number of treatments and the number of replicates. In 1997 and 1998	1997-09-01	2001	Silfor Consulting and several other consulting companies	Main purpose of miniplots was to detect responsiveness of stands at the operational scale. Miniplots were used to select sites for FML trials. It was hoped to be a tool for determining which stands to fertilize operationally.	1997 plots remeasured in 2001	Uniformity and standardization of the screening process could be improved by fall fertilization. It follows that fall fertilization would be best for operational programs also. Late fertilization interfered with N loss and N-mobility pathways. Analyses and interpretations of the 1997 mini plots identified potential	Mini-plots were designed as a pre-screening tool. They are only useful in an operational program if pre-screening for fertilization is desired. Re-measuring miniplots could help assess how well sites have responded over time and if the treatments chosen based on first year	First-year needle response from mini-plots was not always indicative of which full-scale FML sites showed best response. If used as a screening tool in the future this		FRIAA	Hinton Forest Products	Lodgepole Pine	1997 sites in Embarras 6 and McLeod 5; 1998 sites in Embarras 14, McLeod 4, McLeod 18, McLeod 23, and Berland 11; 2000 sites in Marlboro 7 and Berland 9
Hinton Wood Products		Hinton Enhanced Forest Management Program Trial Summaries and Program Direction	Relationship of Site and Stand Characteristics Fertilization Trial	The ROSS fertilizer trial used trials established for another ROSS project. The original ROSS project examined the relationship between site and stand characteristics in fire origin stands in the upper foothills, and looked at relationships between soil and foliar	2001-05-01		Ecotope Consulting	1) To determine how response to fertilizer relates to site and stand conditions and by extension to ecosite. 2)To investigate nutrient status of study stands to determine possible deficiencies and determine appropriate blend of fertilizer. 3) To determine first year foliar response to fertilization of immature high-density lodgepole pine stands, as	no remeasurement	The driest and poorest sites had best response. Ecosites are an effective means to group stands for predicting fertilizer response. N-total may be a better predictor of response than first year needle weight.	The trial was not intended to be an operational program; is was intended applying strategy to establish relationships between stand characteristics and site operationally: Some results could be applied to an operational fertilizer program: all	Ecosite or stand productivity only explained 50% of variation in the needle weight and 64% of the variation in total Nitrogen response.		FRIAA	Hinton Forest Products	Lodgepole Pine	Gregg Bum (McLeod 4), Smith Creek Bum (Berland 6) and Windfall Bum (Marlboro 20)
Hinton Wood Products		Hinton Enhanced Forest Management Program Trial Summaries and Program Direction	Fertilizer Demonstration Plots	McLeod 7 block 33 was clear cut, drag scarified and left for natural regeneration in 1973. In 1987, a manual juvenile spacing treatment was used to reduce stand density from approximately 11,000 to approximately 3,000 stems per hectare. The trial design involved two replicates of four different fertilizer blends (urea a borate	1997-01-01	2001	Silfor Consulting and several other consulting companies	The plots were installed in 1997 to demonstrate to the public the effectiveness of fertilization and thinning treatments in increasing the yield of regenerated stands. A monitoring program was not a part of the project design, but, in the fall of 2001 Weldwood initiated a re-measurement of this trial along with some destructive sampling to study the effect of the treatments.		The results obtained from the 2001 re-measurements and destructive samplings indicate positive growth trends in response to the thinning and fertilizer treatments applied in 1987 and 1997 respectively. The magnitude of the response is not reliable due to lack of	Costs of pre commercial thinning would be similar to the current program.operationally: Costs of fertilization would depend on application method, but would likely be similar to FML costs. Fertilization in young stands may not	This was not a research trial, so there were no replications of treatments. Results have to be viewed in this light.		FRIAA	Hinton Forest Products	Lodgepole Pine	McLeod 7, blocks 33 block 34
University of Alberta, Dept of Renewable Resources	phil.comeau@ales.ualberta.ca	FRIAA Project FFI-16-013 - Final Report	Site index determination using remote sensing - Geocentric and phytocentric Site Index determination in	We focused our analysis on four dominant tree species in Alberta: trembling aspen (Populus tremuloides Michx.), white spruce (Picea glauca (Moench) Voss), lodgepole pine (Pinus contorta Dougl. var. latifolia Engelm.), and jack pine (Pinus banksiana			Ivan Bjelanovic	The objective of this study was to develop and evaluate models for predicting site index for trembling aspen, white spruce, lodgepole and jack pine in Alberta.	Final report date September 23, 2019	Results revealed a significant relationship between SI and environmental factors, with LiDAR derived elevation and climate variables being the strongest predictors. Differences in nature and strength of relationships were found between	These approaches are useful in mapping the variation in productivity at sub-stand levels of resolution.	Although precise SI estimates were obtained with variance explained ranged from 74-85% for different species, models		FRIAA	University of Alberta	trembling aspen, white spruce, lodgepole and jack pine	Our dataset was distributed across three natural regions (Boreal Mixedwood, Foothills, Rocky Mountain) and 10 natural sub-regions (Athabasca Plain, Northern Mixedwood , Dry Mixedwood, Central Mixedwood, Lower Boreal Highlands,
University of Alberta, Dept of Renewable Resources	phil.comeau@ales.ualberta.ca	FRIAA Project - improving site index estimation for Alberta	A. Development of ecologically based site index predictors for regenerated post-harvest stands	Site index is difficult to determine when healthy top height trees are not present, and where estimates of site index are required for advance regeneration or for species not currently present in the stand. Since height growth of post-harvest or regenerated		published in 2019	Ivan Bjelanovic	Develop better site indexes for trembling aspen, white spruce, lodgepole and jack pine using remote sensing (LIDAR) and climate variables.	2015-01-01	2018	Results from this study provide potentially useful estimates of site index for the major tree species in Alberta and Saskatchewan based on ecosite (within natural subregion) or edatope.	Effective site index prediction equations were developed and should have broad general use.	Despite the large sample size and efforts to fill in gaps, the sample size is still small for the less common ecosites.		FRIAA	University of Alberta	trembling aspen, white spruce, lodgepole and jack pine	Most (95%) of sites are located in Boreal Plains ecozone of Canada but a few were located in the Taiga Plains ecozone.
University of Alberta, Dept of Renewable Resources	phil.comeau@ales.ualberta.ca	FRIAA Project - improving site index estimation for Alberta	B. Growth Intercept Models for young white spruce, lodgepole pine and	Growth intercept models for trembling aspen, white spruce and lodgepole pine were developed in this study using stem analysis data collected in young stands.		published in 2019	Ivan Bjelanovic	The purpose of this study was to develop growth intercept models for trembling aspen, white spruce and lodgepole pine for use in Alberta.	data collected in 2017		Poor relationships were found between SI and early height growth suggesting that early height development was more related to factors other than site quality.	Growth intercept models are provided at two reference heights (1.3 and 2 m) as well as for different (3 to 7 years) growth intercept period. The models			FRIAA	University of Alberta	trembling aspen, white spruce, lodgepole and	All sample plots were located within four ecozones in Alberta: Central Mixedwood, Lower Boreal Highland, Lower Foothils, and Upper Foothils.
University of Alberta, Dept of Renewable Resources	phil.comeau@ales.ualberta.ca	FRIAA Project - improving site index estimation for Alberta	C. Growth Intercept Models for released advance regeneration of white spruce	Height-age curves were used to develop a site index predictive model for released advance white spruce regeneration (variable height post release growth intercept models) based on post release height increment and height at the time of release.			Ivan Bjelanovic	Test the use of a growth intercept approach to develope a site index for post release height growth of spruce advance regeneration following overstory removal.	data collected in 2011, 2016, 2017		A variable height growth intercept type model was developed based on relationships between five year height increment, site index and tree height at the beginning of the 5 year period.		While this approach appears to provide a potentially useful approach for estimating site index based on height growth determined for the most recent 5 year		FRIAA	University of Alberta	White Spruce	Central Mixedwoods subregion of Alberta