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Progress and Achievements

Foothills Growth and Yield Association

The First Decade April 2000 – March 2010

Early attempts to establish an Alberta lodgepole pine cooperative in the 1990s showed some promise but little progress until 1999, when the Foothills Research Institute (then Foothills Model Forest) approached Dr. Dick Dempster to spearhead an initiative to revive this partnership and put it on a firmer path to success.

With seed funding from the Institute to support initial planning, nine pine-based Forest Management Agreement holders agreed to embark on this new enterprise under the name of the Foothills Growth and Yield Association. Alberta Sustainable Resource Development (in 1999, Department of Environment) also recognized the importance of the initiative and appointed the Executive Director of the Forest Management Branch (formerly Forest Management Division) to represent the Department on the Association's steering committee.

This document reports on highlights of the Association's progress and achievements over the first 10 years, and outlines some of our anticipated future directions.

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MESSAGE FROM THE CHAIR

Greg Branton
ALBERTA NEWSPRINT

Reviewing this summary report of the first ten years' accomplishments of the Foothills Growth and Yield Association reminds me that time passes both slowly and quickly. In many respects it seems like only yesterday we were meeting to discuss the idea of creating a partnership focused on learning how lodgepole pine stands develop up and down the Eastern Slopes. Conversely, looking at the results reminds me that our collaboration to date spans just over ten percent of the economic life cycle of the stands managed by our membership.

From the outset, the members of the FGYA reminded each other of the importance of "keeping it simple" and staying focused on a few vital questions, answers to which would assist forestry practitioners with the tough decisions they face. I am proud that we maintained that focus and as a result are able to deliver meaningful results.

Most significant to me is what we have learned about predicting regenerated stand development, including the major role that ingress and other factors play. The early understanding we are gaining of the role of climate change, not only directly on the growth of managed stands, but also on the pathogens that are affecting their development, will be invaluable as we adapt our management practices to a changing environment.

I am convinced that the models that the Association has developed for predicting the dynamics of both planted and naturally regenerated lodgepole pine in young managed stands, and the decision support tool for stand management after mountain pine beetle infestation, will pay large dividends to forest managers over the next decade.

Lodgepole Pine

In the upcoming years the Association will continue to develop more data and improved knowledge critical to the management of lodgepole pine in Alberta. As this report says, "These data and knowledge will be used to enhance and expand the preliminary regeneration model, replacing current interim projections with robust and reliable empirical data." I agree with this assessment, but would like to challenge both members and non-members of the FGYA to start using now the information and knowledge gained to improve what we are doing on the ground. This includes improving silviculture prescriptions for harvested lodgepole pine stands, and for stands killed by mountain pine beetle. We need to go beyond answering how climate change will affect lodgepole pine stand and pathogen dynamics, and ask ourselves how we should be adapting our reforestation methods in light of these changes.

I feel we should all be proud of the terrific work that has been completed. Our challenge is to find ways of taking this new-found knowledge and using it in our day to day practices.

Greg Branton
Alberta Newsprint

INTRODUCTION

BRUCE MAYER, ASSISTANT DEPUTY MINISTER, FORESTRY DIVISION
ALBERTA SUSTAINABLE RESOURCE DEVELOPMENT

Bruce Mayer

When the Foothills Growth and Yield Association (FGYA) was formed on April 1, 2000, few could have foreseen the association's effectiveness over the next ten years. The original objective of the companies that joined was to participate in a cooperative program for forecasting and validating managed stand growth and yield, particularly of lodgepole pine. Sustainable Resource Development (SRD) joined as a non-voting member to promote the scientific development and validation of yield forecasts. The Association has made great strides toward realizing these goals, which has assisted SRD priorities. The long-term growth study of planted lodgepole pine is starting to yield very interesting results, including an indication that climate change is having a significant effect on seedling survival and growth.

The FGYA has prepared several very informative fact sheets on a number of topics related to lodgepole pine management. These summary notes have provided very useful references in a user-friendly and convenient format to foresters and non-foresters interested in learning more about the species.

Foresters in western Canada know the damage mountain pine beetle (MPB) can cause to pine forests. In 2007, the FGYA organized a tour of British Columbia areas hard-hit by this forest pest, so that industry representatives and government staff could see, first-hand, the significant damage the beetle can cause. Tour participants were able to speak with a number of forestry representatives who are on the front lines of the beetle battle in BC. That trip helped SRD formulate its policy and action plan for combating MPB. FGYA is sponsoring a three-year project with the Forest Resource Improvement Association of Alberta to study the implications of post-MPB attack on pine stands, and potential management interventions and silvicultural strategies. Results will help SRD and the forest industry mitigate the middle- and long-term impacts on timber supply and forest cover.

Locating the Association at the Foothills Model Forest (now the Foothills Research Institute) has also proven to be a good choice. That agency has provided excellent support at low cost over the years.

I congratulate the Foothills Growth and Yield Association, and particularly the various chairmen over the years, on developing a very useful and effective organization that has fostered cooperation and collaboration between forest management agreement holders and SRD. We plan to continue our close working relationship with the members of the association, and look forward to many more years of successful participation in the future.

EXECUTIVE SUMMARY AND HIGHLIGHTS

This report summarizes the first 10 years of work by Foothills Growth and Yield Association (FGYA).

The Association's mandate is to expand understanding of lodgepole pine's growth patterns in natural and regenerated stands, and to develop tools by which this knowledge can be applied in forest management. Our work is supported by research plots located across virtually the full range of lodgepole pine in Alberta.

Some highlights of the knowledge gained during this period:

- Regenerated stand performance is more predictable than originally thought, when appropriate measurement methods and standards are used.
- Ingress of natural regeneration often continues beyond the establishment survey stage, and on many sites planting is unnecessary or even counterproductive for achievement of yield targets.
- Preliminary work shows mean annual temperature rose in the study area by 0.8^{0}C in the past 25 years. If this climate trend continues, average mortality rates could double within 10 to 20 years. The impact of climate change, and related pathogen problems like mountain pine beetle, on long-term timber supplies is yet unknown, but is already confounding assumptions based on historical growth and yield.
- Tending and spacing can be beneficial on some sites but on other sites they appear to increase access by damage agents and limit the number of potential crop trees.
- Fertilization and thinning may increase productivity, but may also increase susceptibility to pathogens and extreme climate events (which may be increasing with climate change)
- Similar results from two studies, one measured over a span of 50 years, confirm higher site indices in managed stands compared to fire origin stands, particularly on medium and poor sites.

Members of the Association share the common objective of productive and healthy regeneration following harvest of fire-origin lodgepole pine
PHOTO: BRIAN CARNELL, FRI

Using this research, the Association has developed preliminary regenerated lodgepole pine models for both planted and naturally regenerated lodgepole pine, and a preliminary decision support tool for mountain pine beetle post-infestation stand management.

In the next five years, trial measurement and analysis will continue to yield data and knowledge critical to the management of lodgepole pine in Alberta. Notably, the 408 plots in Project 2 will have been measured every year from establishment to performance survey age, and will be used to enhance and expand the preliminary regeneration model, replacing current interim projections with robust and reliable empirical data.

Enough work has been done in the first 10 years to lay the foundation for operational trials testing the application of FGYA research and planning tools, and the Association looks forward to these trials proceeding under the stewardship of its membership and others in the next few years.

Then and now: Sundance Forest Products RLP trial plot in 2002; Forest Planner Pat Golec at the same research installation in 2009

SHARED DIRECTIONS

Forest companies joined the Foothills Growth and Yield Association to cooperate in a program of forecasting and validating managed stand growth and yield, particularly of lodgepole pine. The Alberta government desired to promote the scientific development and validation of yield forecasts used by tenure holders in the development of forest management plans. Foothills Research Institute looked to promote cooperation and shared responsibility in the improvement of sustainable forest management practices.

The interests of all these partners were brought together in the Mission of the FGYA, which is to continually improve the assessment of lodgepole pine growth and yield in managed stands by:

- Forecasting and monitoring responses to silvicultural treatments;
- Facilitating the scientific development and validation of yield forecasts used in managing tenures;
- Promoting knowledge, shared responsibility and cost-effective cooperation.

The primary focus to date has been on forecasting the development of post-harvest managed stands. This is particularly important because of the urgent need for the development and refinement of regeneration standards linked to growth and yield. FGYA members also recognize that experimentation and assessment of fire-origin stands continue to be relevant and necessary (a) for yield forecasting and sound silvicultural decision-making in post-harvest stands, and (b) the ability to predict responses to potential interventions such as thinning and fertilization.

Given this, the Association established research and development priorities as follows:

1. Responses to planting, vegetation management and density regulation treatments in post-harvest regenerated stands. (see Project 2)
2. Mortality, forest health and risk management in post-harvest regenerated stands, including the effects of climate change. This includes the impact of mountain pine beetle on forest health and post-beetle regeneration and stand management strategies. (see Projects 2, 5, 7)
3. Investigations of spacing, tending, nutrition and thinning in post-harvest regenerated stands including the application of results from density and nutrition management trials in fire-origin stands. (See Projects 4, 6)
4. Impacts of density management on wood quality over time, through work undertaken by the Canadian Wood Fibre Centre with the FGYA assisting in field measurements.

Gordon Baskerville, former Dean of Forestry at the University of New Brunswick said it best – and frequently: "What gets measured, gets managed." The forest management planner who sets out to determine appropriate and sustainable harvest levels across time is beset by uncertainty without the scientific foundation with which to assess or measure the productive capacity of lodgepole pine ecosystems, and the rates at which both fire origin and regenerated stands establish and grow across a range of conditions and management regimes. This is the challenge that brought together and sustains the partnership of the Foothills Growth and Yield Association.

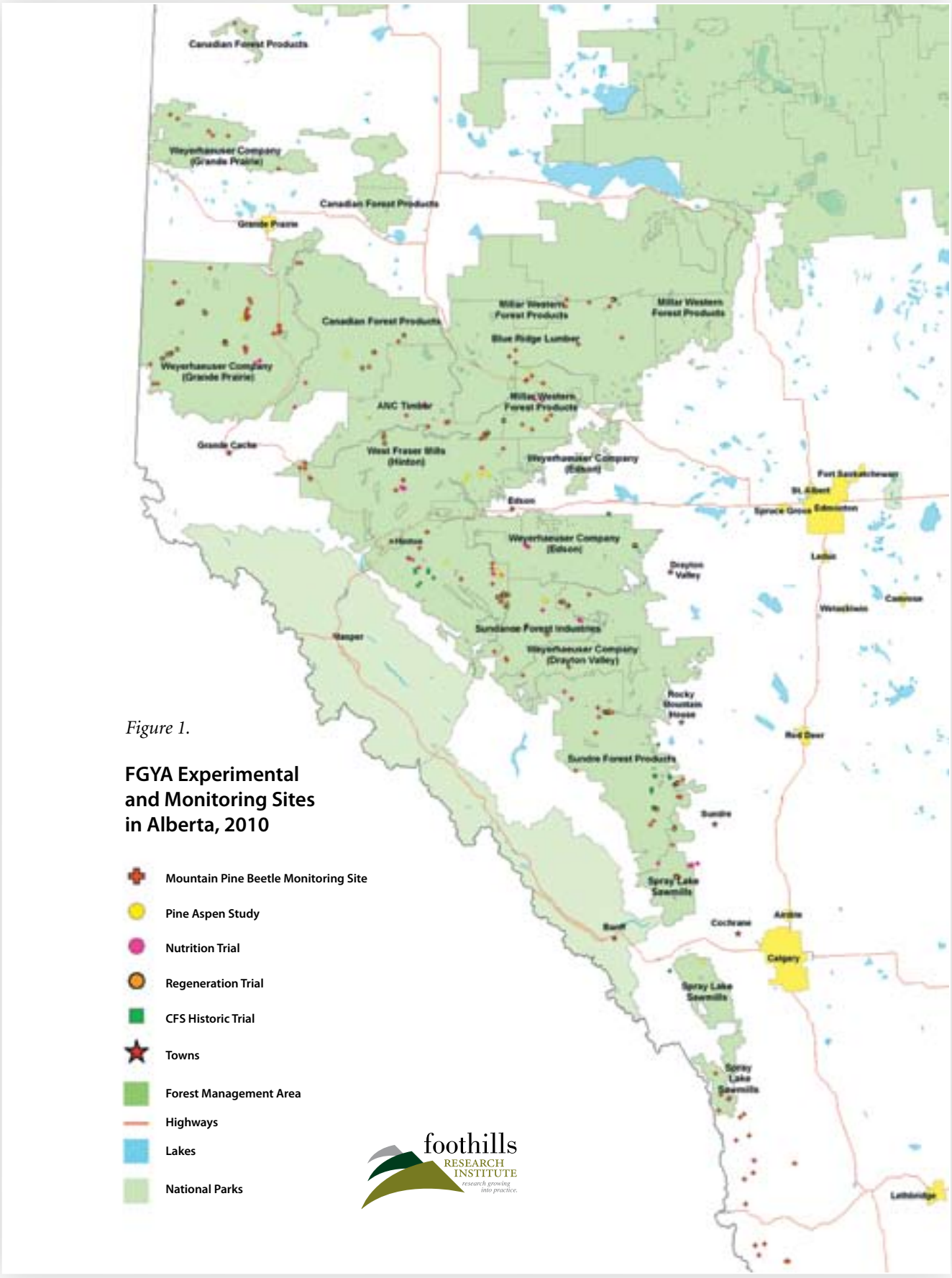


Figure 1.

FGYA Experimental and Monitoring Sites in Alberta, 2010

PROJECTS AND FIELD TRIALS

The mandate of the FGYA is being met by work on seven projects throughout nine forest management areas (Figure 1) covering most of the Foothills region.

PROJECT 1

Development and Management of the Association

The Association works to meet the shared research needs of our members cooperatively and cost-effectively. Primary activities under this heading are program planning and management, field coordination, technical meetings, field tours, data analysis and dissemination of information.

PROJECT 2

Regenerated Lodgepole Pine Trial (2000-ongoing)

This trial was the first major effort of the Association, and continues as its flagship project. Most of the earlier silvicultural research on lodgepole pine in Alberta focused on fire-origin stands. This left a major gap in our knowledge of the growth and yield of regeneration following harvest. Effects of site quality, stand conditions and reforestation treatments on the establishment and performance of both natural regeneration and planted stock are complex, and difficult or impossible to assess without controlled experimentation.

Ten years ago the FGYA installed 408 field plots across the forested landscape of Alberta to annually measure, monitor and forecast the development of lodgepole pine regenerated after harvesting, under different management regimes. (Figure 2) FGYA member companies installed the plots and treated them, and continue to measure them every second year with quality checks in the intervening years. Results are being used to project crop performance against Alberta regeneration standards, and to link establishment and performance targets based on these standards to each other and to longer-term yield targets.

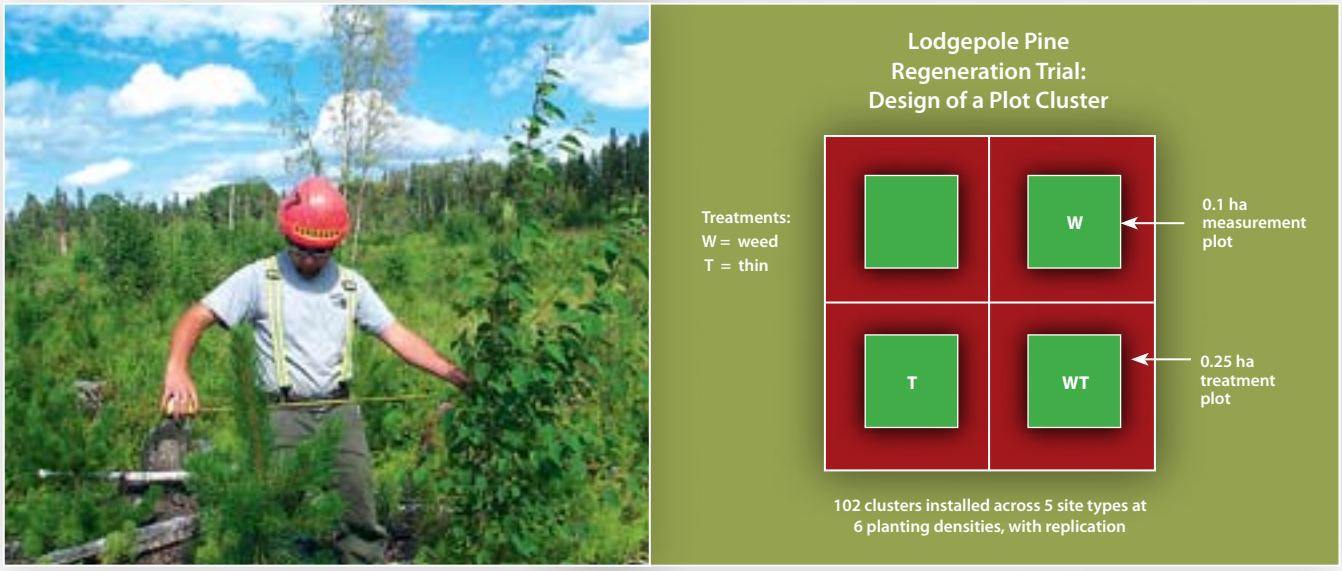


Figure 2.
RLP trial – design and measurement
PHOTO: WESTSKY RESOURCES

PROJECT 3

Comparison of Pre- and Post-Harvest Stand Development (2002-ongoing)

The purpose of this project is to gain and share knowledge of how stands regenerated after harvesting differ from natural stands. An initial study was conducted to compare productivity in mature fire-origin stands with productivity in stands regenerated following harvest. (Figure 3) Comparisons involved contemporaneous sampling of paired-plots in adjacent regenerated and parent stands in combination with analysis of time-series data from permanent sample plots measured before and after harvesting.

Because of limitations inherent in the paired –plot design and the projections made using these data, results from the initial study were subsequently compared and validated with data from long-term spacing trials.

In 2006 the FGYA, in cooperation with the Foothills Model Forest and the Alberta Forest Genetic Resources Council, hosted a conference on post-harvest stand development. Information integrating growth and yield, genetics, silviculture and forest health was shared by 25 international speakers and 150 delegates.

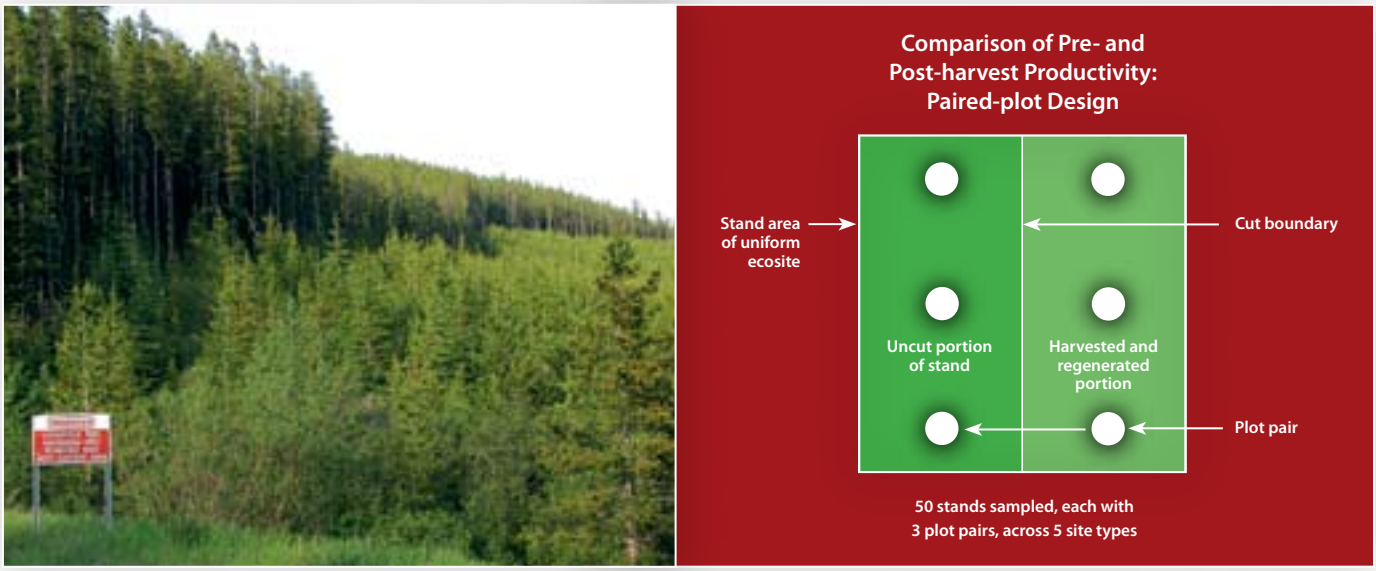


Figure 3. Current and projected growth of young harvest-origin stands were compared, close to stand boundaries such as shown in the photograph, with historical growth rates of their fire-origin predecessors.

PROJECT 4

Historic Research Trials (2002-ongoing)

Thanks to the foresight of earlier researchers we are able to unlock a wealth of information about the response of lodgepole pine to silvicultural treatments from more than 20 historic field trials. Since 2002 the FGYA has maintained and re-measured these trials on a five-year schedule under an agreement with the Canadian Forest Service and the Alberta government. See Table 1. The results are being used to assess density management strategies, reliability of growth and yield models, and effects of silvicultural treatments on wood quality. All the trials have been fully documented, and interpretive signage has been placed at the most valuable and accessible locations.

The Association cooperates with the Canadian Wood Fibre Centre of the Canadian Forest Service, and with Alberta Sustainable Resource Development, to provide forest managers with the continued benefit of historic field trials, some established more than 50 years ago. Ongoing activities involve maintenance and protection of the field installations, periodic re-measurement, analysis and interpretive signage.

A field tour in 1999 that visited the plots listed in Table 1 was instrumental in building the partnership that soon afterward became the Foothills Growth and Yield Association. These historic trials go back as far as the 1930s; indeed German prisoners of war were put to work doing some of the thinnings at the Canadian Forest Service's Kananaskis Research Station in 1941.

The 1999 Field Tour visited the "Muttart Forest" (Nojack). The tour was instrumental in creation of the FGYA. Conditions during the tour went from a freak snowfall in central Alberta to seasonal fall conditions at Kananaskis.

Table 1 **Historic Research Trials Included in FGYA/SRD/CWFC Project**

Historic Research Trials	Year Established	Historic Research Trials	Year Established
Pre-commercial thinning, Mackay	1954	Juvenile spacing of 25-year-old lodgepole pine, Teepee Pole Creek	1967
Spacing trials – 7 year old fire origin stand, Gregg River	1963/64	Strip thinning of lodgepole pine, Teepee Pole Creek	1966
Spacing trials – 28 year old fire origin stand, Gregg River	1984	Heavy thinning of 77-year-old stand, Kananaskis	1941
Thinning and fertilization of 40-year-old stand, McCardell Creek	1984/85	Various thinnings based on European practices, Kananaskis	1938/39
Mechanical thinning treatments, Swan Lake	1977	Commercial thinning in an 88-year-old stand, Kananaskis	1950
Ricinus thinning	1975	Commercial thinning in an 85-year-old stand, Strachan	1952
Fertilizing after thinning 70-year-old lodgepole pine, Clearwater	1968	Fertilization and thinning of 26-year-old lodgepole pine, Edson (Takyi Trial, SRD)	1980

PROJECT 5

Regional Yield Estimators (2002-ongoing)

The Association cooperated with Alberta Sustainable Resource Development, which wished to link growth and yield models to the Alberta Vegetation Inventory, enabling the Department to report credibly on both the current state of provincial timber resources and their rate of growth.

PROJECT 6

Enhanced Management of Lodgepole Pine (2004-ongoing)

Pine-aspen Density Management Study

In 2004 the Association, in a cooperative research agreement with the University of Alberta, began a project to address gaps in the knowledge required to enhance lodgepole pine growth and yield through nutrition and density management in both fire-origin and post-harvest stands. It includes two sub-projects (a) pine nutrition and density management in young and mid-rotation stands (see Figure 4), and (b) pine-aspen density management following harvest and reforestation.

The pine-aspen study is complete. Data were analyzed to explore the competitive effects of aspen, spruce and pine on pine growth.

Data from the pine nutrition and density study have been analyzed to assess the effects of thinning and fertilization on snow damage, the effect of fertilization on diameter growth and root carbohydrate concentrations, and foliar nutrient uptake in fertilized post-harvest stands. We are currently consolidating results and conducting some additional checks and analyses before finalizing plans for further measurements 6 to 9 years after treatment, to fully assess stand growth response.

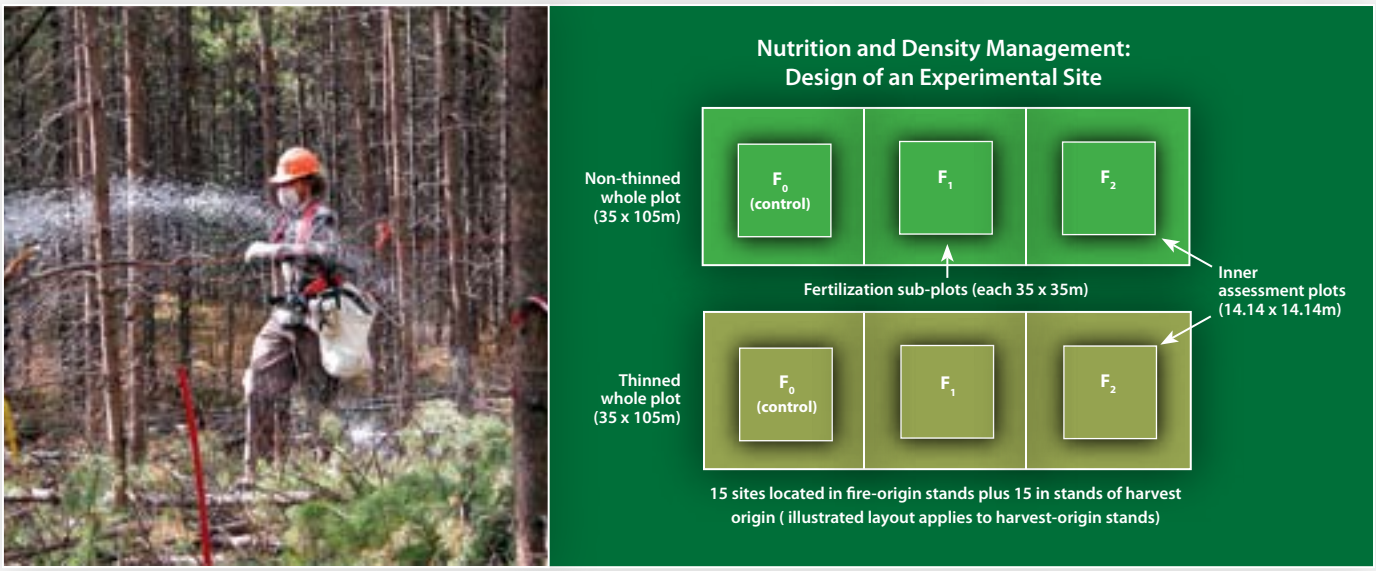


Figure 4. Nutrition and Density Management trial – plot design and fertilization treatment

PROJECT 7

Regeneration Management in an Mountain Pine Beetle Environment (2008-ongoing)

Opposite page: Beetle-killed lodgepole pine near Grande Prairie, 2009.
PHOTO: ALBERTA SUSTAINABLE RESOURCE DEVELOPMENT

High levels of infestation and mortality in the lodgepole pine forests of Alberta are expected, yet the knowledge with which to address post-infestation treatment is rudimentary. The objective of this project is to provide tools for assessing treatment options (e.g. salvage, partial-cutting, site preparation, re-planting, fertilization, density management) and their growth and yield implications, for pure and mixed-species lodgepole pine stands attacked by mountain pine beetle.

Working with the Mountain Pine Beetle Ecology Program of the Foothills Research Institute, as well as our industry and government partners, we have established a network of 240 permanent sample plots to monitor impacts of beetle attack on stand development. Plots already installed by the Alberta government and forest industry, some over 50 years ago, have been used for this purpose, thus providing essential historical data for benchmarking pre-attack conditions, as well as the basis for post-attack monitoring.

LEARNINGS IN THE FIRST 10 YEARS

Over the 10 years covered by this report, and particularly over the last five years as results have become available from trial re-measurements, we have learned much about the establishment and growth of managed lodgepole pine. Some of the more important findings, and their possible implications for management, are outlined below.

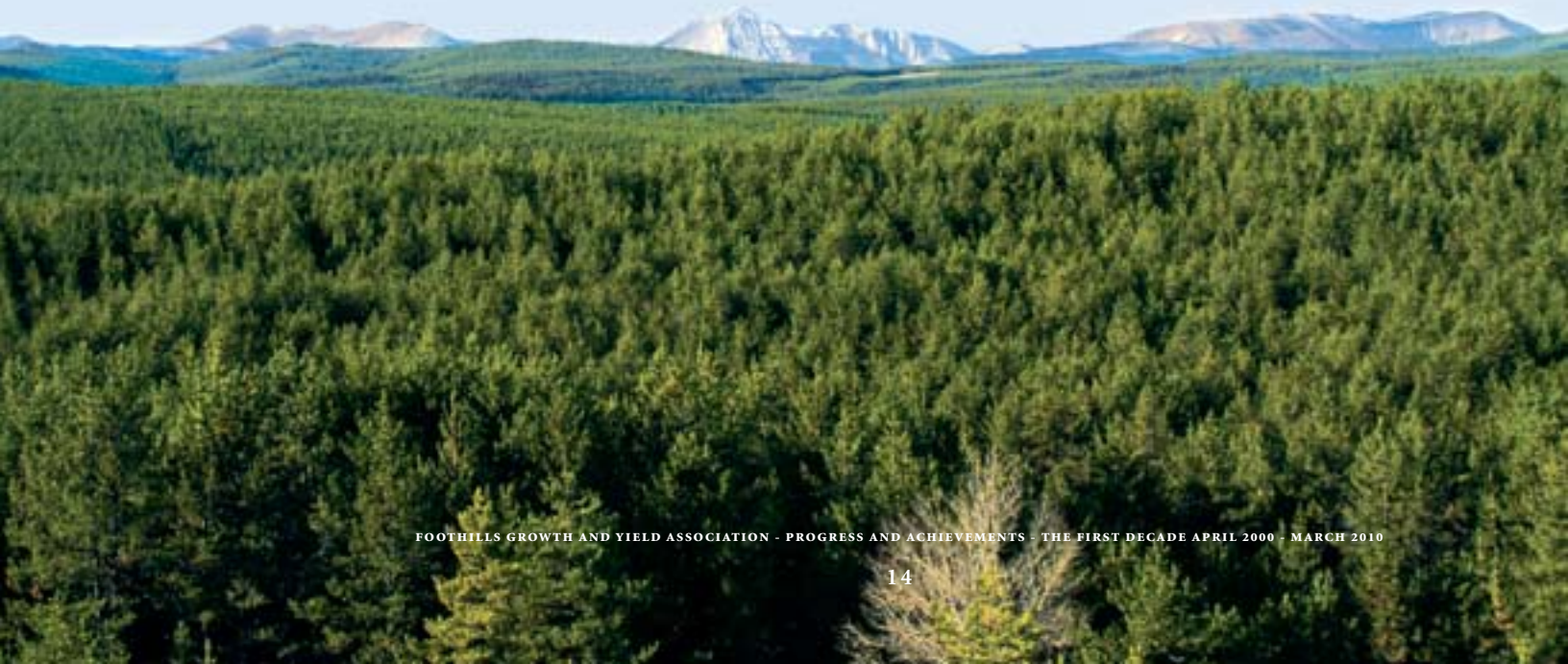
1. Prediction of Regeneration Performance

The new trials, backed up by earlier and supporting studies, have greatly improved our ability to use early surveys and other available stand information to quantitatively project regeneration performance in relation to site quality and silvicultural treatments. Regeneration performance of lodgepole pine is more predictable and less chaotic than we originally expected, providing that the following requirements and conditions are met:

Re-measuring an RLP trial plot in a 10-year old stand

- The effects of site quality, stand density and vegetation management are distinguished (this was achieved by controlled experimentation);
- Stand dynamics of regeneration differ from those on which most conventional growth and yield models are based, therefore different input data and modelling approaches must be used at least until crown closure occurs;
- Planted stock and natural regeneration follow different development trajectories and must be differentiated where both are present;
- The effects of mortality of planted stock and ingress of natural regeneration are separated (failure to do so results in incorrect estimation of crop age and projections of stand density);
- The timing of establishment surveys are adjusted where necessary to reflect significant levels of late ingress;
- Statistical distributions of tree size and density are taken into account (this has been accomplished by modelling with the Regenerated Lodgepole Pine Trial data);
- Basic stand history information is provided and supplemented with a simple but appropriate ecological classification.

Young lodgepole pine backdropped by the Rockies – Highway 40 North



2. Climate Impacts

Climate change is further complicating the forecasting of growth and yield, and this problem is not confined to uncertainty introduced by the mountain pine beetle epidemic.

Analyses of the Regenerated Lodgepole Pine trial and other data indicated that, as in other parts of north-west North America, the dynamics of forest growth and "background" mortality are changing. Mean annual temperatures in the study area have increased 0.8°C over the last 25 years. This trend, in conjunction with a reduction in precipitation, has led to higher drought indices, and appears to be increasing the susceptibility of young lodgepole pine to not only direct climate injury, but also to mortality from root disease, root collar weevils and other pathogens.

Trends observed across a wide range of elevation, latitude and other site conditions showed mortality of immature lodgepole pine to differ between sites (see Figure 5) but on average to double with every 0.3°C temperature increase. On the basis of this and expected continued temperature increases, average mortality rates could double within 10 to 20 years compared to current levels. These results are recent and require further study, but are consistent with observations elsewhere and have potentially serious operational implications for planting, pest management, tending, species selection and deployment of seed and genetically improved stock.

Figure 5 shows the analysis (2010) of two data sets collected 20 years apart, showing remarkably consistent results. Annual mortality rates of young lodgepole pine show a strong exponential relationship with mean annual temperature of the site. Mortality (note the logarithmic scale on the vertical axis) doubles for every 0.3°C increase in temperature (shown on the horizontal axis). This general trend held true for data from two studies conducted at different locations over different time periods: one in planted lodgepole pine between 2001 and 2006 (RLP trial – red symbols), and another in naturally regenerating stands between 1981 and 1990 (Ives study – blue symbols). If the trend is also found to hold true for temperatures forecast to increase over time because of climate change, average mortality rates of lodgepole pine in the Alberta Foothills could double within 10 to 20 years relative to current levels. Deviations from the general trend appear to result from site or treatment factors. For example, the 5 outlying samples circled at the top left of the scatter plots are located on poorly drained acidic upland sites where survival of planted stock might actually benefit from warmer temperatures.

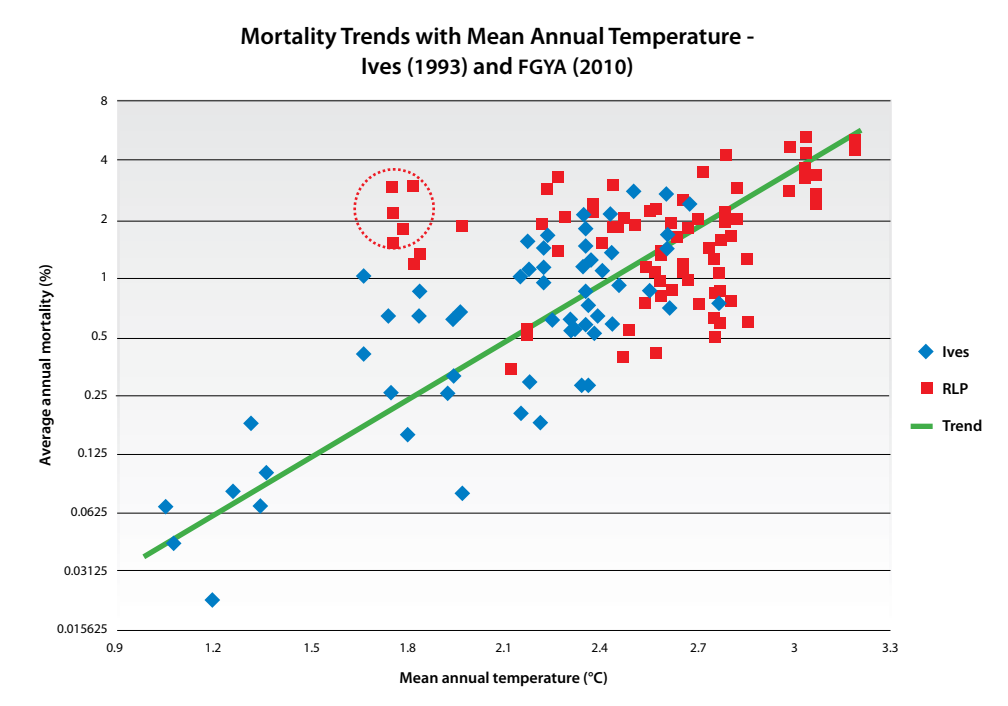


Figure 5. Mortality trends with Mean Annual Temperature: Two Data Sets, Similar Findings – A Forest Management Dilemma

Regenerated stand suffering from root disease, root collar weevils and rusts. These pathogens appear to be increasing, possibly as a result of climate change.

3. Planting and Natural Regeneration – Ingress and Mortality

The final stocking level of a regenerated forest stand depends on the net outcome of two competing influences: ingress and mortality.

A - Ingress

Research by the FGYA (Figure 6) has been consistent with the findings of earlier studies[1] which were, in light of current research, remarkably prescient.

Natural regeneration establishment is influenced by site factors (including climate) and treatments (such as mechanical site preparation). Even with early and optimum treatment to favour germination, ingress occurs over a protracted period of time. Indeed, substantial amounts of ingress occur on some site types after conventional regeneration surveys are required, the results of which must be used to judge establishment success. This has perhaps contributed in the past to a reluctance to rely on natural regeneration for meeting reforestation targets.

The contribution of planted stock to final yields at rotation, however, is likely to be lower

1 Crossley, D.I. 1976. The ingress of regeneration following harvest and scarification of lodgepole pine stands. *Forestry Chronicle* February 1976.

Ives, W.G.B. and C.L. Rentz. 1993. Factors affecting the survival of immature lodgepole pine in the foothills of west-central Alberta. *Forestry Canada Information Report NOR-X-330.*

Johnstone, W.D. 1976. Ingress of lodgepole pine and white spruce regeneration following logging and scarification in west-central Alberta. *Canadian Forest Service Information Report NOR-X-170.*

Ingress of natural regeneration in harvested stands like this may continue for over 12 years. – PHOTO: BRIAN CARNELL, FRI

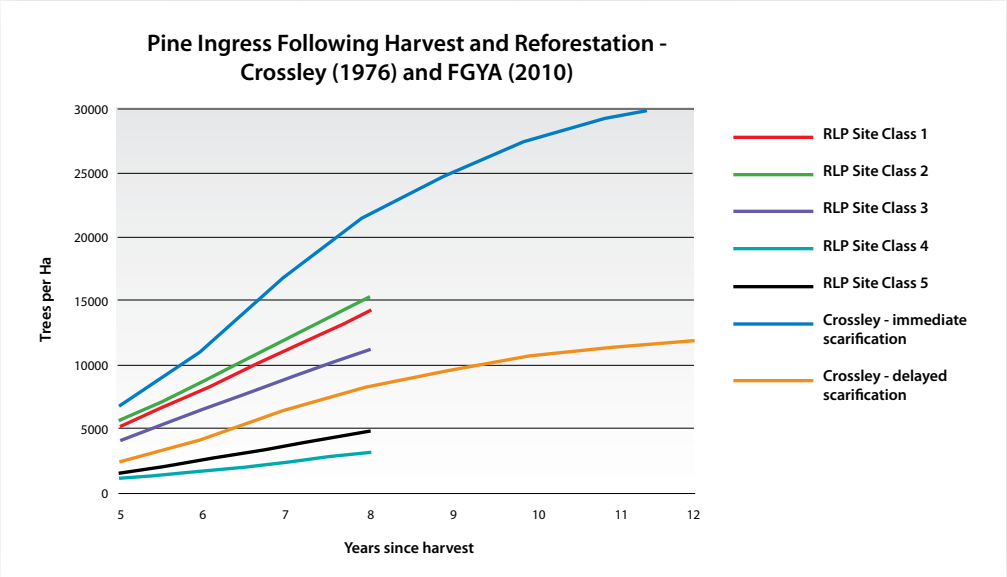


Figure 6. Natural regeneration ingress trends for lodgepole pine – Two Studies, Similar Findings

than previously expected on some sites because of high and increasing levels of mortality in the planted trees, accompanied and offset by high rates of ingress of natural regeneration.

Figure 6 shows the results of two studies separated by over 30 years. In the mid 1960s, Chief Forester Des Crossley of Northwestern Pulp & Power (now Hinton Wood Products) was concerned over the required stocking levels at survey age in the regeneration standards of the time. He installed a series of tracking plots across his forest management area on which he counted regeneration stocking levels annually for many years, showing that ingress continued well beyond the cut-off date for stocking at the time. The FGYA's Regenerated Lodgepole Pine Trial trends have not yet been measured or analyzed beyond eight years of stand age, but based on results to date and Crossley's earlier published study, it seems likely that ingress will continue beyond eight years.

B - Mortality

Mortality in young planted lodgepole pine, as observed in the Regenerated Lodgepole Pine Trial, is a concern given its persistence and likelihood to increase with climate change. Ives and Rentz' earlier study also reported persistent mortality in natural regeneration. However, on many sites ingress of natural regeneration is more than sufficient to offset high mortality (see Figure 7). Planting on such sites may not only be an unnecessary expense, but could be exacerbating climatic and pathogen threats to forest health. On sites where natural ingress is sometimes insufficient, such as rich and moist sites in the Lower Foothills, planting pine can be particularly risky, and further investigation is required to identify alternative strategies for maximizing productivity and minimizing health risks.

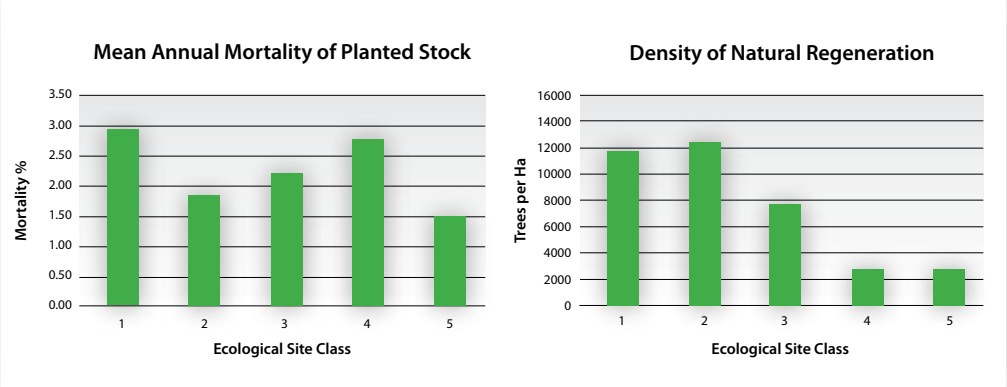


Figure 7. Mortality of planted stock and average density of natural regeneration in the Regenerated Lodgepole Pine Trial 7-8 years after planting

4. Tending, Thinning and Fertilization

Tending and spacing can be beneficial on some sites by increasing vigour, reducing competitive stress, and removing dead, dying and susceptible trees. But on other sites they can be detrimental by increasing access by damage agents and limiting the number of potential crop trees. Similarly, fertilization and thinning have the potential to increase productivity, but they can increase susceptibility to pathogens and (as demonstrated by the nutrition and density field trial) extreme climate events, incidence of which may be increasing with climate change.

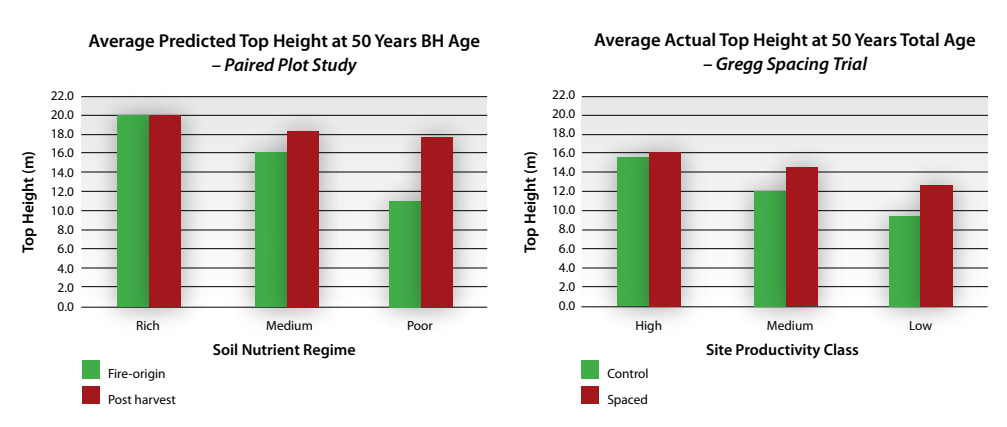
In the first 10 years of stand growth, brushing of competing vegetation significantly increases the diameter and basal area growth of young lodgepole pine, but in the Regenerated Lodgepole Pine Trial it has not yet demonstrated a major effect on height growth, ingress of natural vegetation, or mortality. In older stands measured during the pine-aspen study, the effect of competition on height growth was still observed to be quite limited, though significant on some sites.

While control of aspen when it exceeds threshold basal areas of 5-9 m^2 per ha may be beneficial to lodgepole pine growth and to conifer yield, the author of the pine-aspen study report concluded that retention of a component of aspen is desirable for maintenance of biodiversity and site productivity. Retaining moderate to high densities of aspen may reduce the growth of lodgepole pine, but some level of retention could provide protection against risk of stand loss to mountain pine beetle and other damage agents.

Aerial view of Gregg spacing trial, low productivity site.

The Project 3 "paired plot" study indicated that regeneration practices following harvesting which moderate densities while maintaining or improving site occupancy are likely to increase productivity relative to that of untreated fire-origin stands. This conclusion is supported by more recent analyses of the Gregg spacing trial (Project 4). Results of the two studies are compared in Figure 8. The paired-plot study predicted similar site indices for fire-origin and managed stands on good sites, and significantly increased site indices on poorer sites. In the Gregg trial, top height development to 50 years total age has been little influenced by spacing on good sites, but significantly increased on poorer sites. The best opportunities for spacing or pre-commercial thinning of lodgepole pine appear to be on poorer sites. On rich sites thinning may be ineffective or counterproductive, particularly in view of increased risks of mortality related to climate and pathogen damage.

Figure 8. Stand productivity trends shown by two studies (see text for explanation)



5. Mountain Pine Beetle

During the last five years the Alberta government and industry members of the FGYA have increasingly stressed the need to understand the impact of mountain pine beetle attack on habitat, regeneration and timber supply.

It will be several years before we have sufficient data from our Permanent Sample Plots monitoring program, and other studies initiated by our partners, to comprehensively forecast post-attack stand development. Our first steps in meeting the need were to find out what other jurisdictions, already confronted with such epidemics, have already learned. The FGYA organized a tour of mountain pine beetle-affected areas in the Prince George Forest District of British Columbia in 2007, and held a mountain pine beetle -silviculture workshop in 2009 with guest speakers from B.C. and New Brunswick. Lessons learned, and incorporated into reports of these events and our subsequent analyses, included:

- Development of effective silvicultural strategies for mitigating timber supply impacts will require knowledge of how much secondary structure exists (trees, saplings and seedlings likely to survive attack in pine-leading stands), and how this structure will perform in the future;
- Salvage will not always be feasible or desirable, and control burning while seed from dead timber remains viable will probably be necessary in unsalvageable stands that lack appropriate secondary structure;
- Knowledge of the potential of attacked stands to naturally regenerate without salvage and conventional site preparation is crucial but scarce;
- "Shelf life" of killed timber varies from five-20 years and depends on site, utilization and market factors, some of which can be predicted.

FGYA tour group with British Columbia Ministry of Forests Hosts and Alberta Sustainable Resource Development guests - Prince George Region May 2007

APPLICATIONS FOR IMPROVED FOREST MANAGEMENT

Over the last five years we have focused on two main areas for applying knowledge to management decision-making: post-harvest reforestation and management of stands attacked by mountain pine beetle.

1. Post-Harvest Regeneration Model

What we have learned over the last decade has provided a basis for:

- Forecasting early development of lodgepole pine stands against Alberta regeneration standards (RSA);
- Linkage between initial stand conditions and achievement of yield targets at rotation;
- Identifying what silvicultural treatments are required to meet RSA and yield targets;
- Prediction of tree mortality and risk of regeneration failure from climate variables, thereby not only improving short-term prediction of crop performance, but also providing a basis for assessing impacts of future climate change.

These have been consolidated into an easy-to-use regeneration model. See Figure 9 (facing page). The model provides silviculturists with forecasts of attributes recognized in RSA surveys and standards, and forest planners with predictions that can be used as inputs to models (that we are currently validating against historic trial data) forecasting growth and yield at later stages of stand development. For the first time such attributes can be forecast from early stand conditions measured in stocking or establishment surveys.

Users of the model specify an ecological site class, vegetation management treatment and other basic stand history information. They may input their own survey information if available, or rely on default values based on treatment and site. The model predicts height and diameter growth, ingress, mortality, density, stocking, and basal area to RSA performance survey age (12 – 14 years).

2. Management of Beetle-Attacked Stands

In Alberta we have much to learn over the next few years about how stands will respond to mountain pine beetle attack. But in the meantime important decisions have to be made about where, when and how to treat attacked stands in order to minimise the loss of timber, habitat and other values from the forest. We have assembled the best currently available information on pre-attack conditions, "shelf-life" of killed trees, growth response of the residual stand, and regeneration dynamics to support such decisions. See Figure 10 (facing page).

The resulting decision-support tool helps managers assess the impacts of different levels of mountain pine beetle infestation, and various silvicultural interventions, on post-attack stand development. Users define simulation scenarios by specifying a growth model, ecological site class, stand structure, species composition, stand age, mountain pine beetle severity, and silviculture intervention. In 2011, the DST is being revised to incorporate additional stand types not addressed in the current version. For each defined scenario, the decision support tool searches and reports from a database containing the best available stand growth projections. Forest growth projections are made using both GYPSY and MGM, the two models currently available for Alberta's forest stand types. Simulation results include tabular and graphical reports of standard mensurational stand growth attributes, and post-beetle wood quality metrics, for 100 years and 10 years post-attack, respectively.

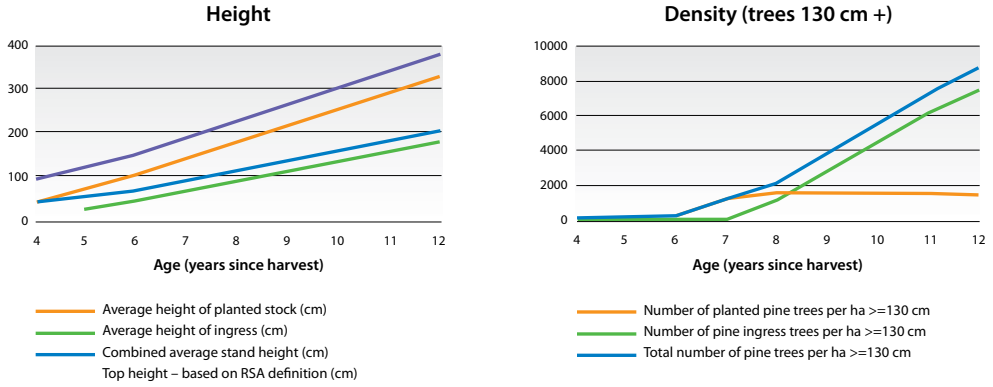


Figure 9. Examples of reforestation performance forecasts by the Lodgepole Pine Regeneration Model

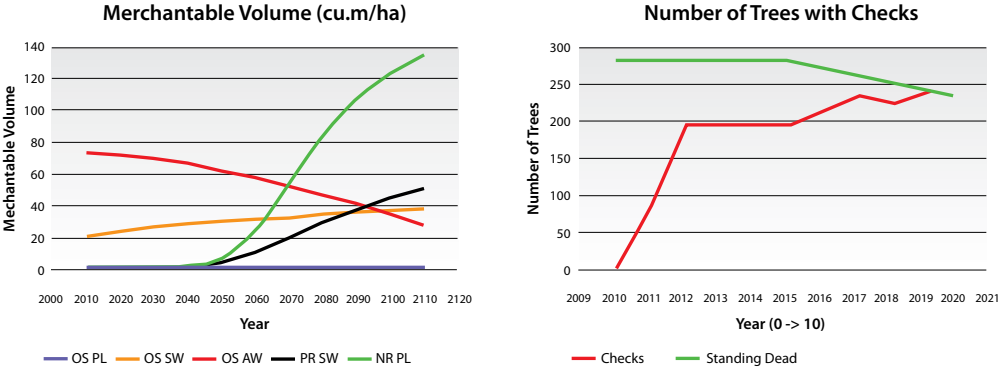


Figure 10. Example of wood quality forecasts by the MPB Decision Support Tool

MONITORING AND FEEDBACK

A Framework for Continual Improvement

Sustainable forest management is dependent on monitoring of actual forest growth relative to that which has been predicted, and periodically adjusting forest management plans accordingly. The FGYA is supporting the application of this principle in Alberta by several on-going monitoring commitments:

- The Regenerated Lodgepole Pine Trial is being used to monitor growth of harvest-origin lodgepole pine relative to regeneration standards and the predictions of growth and yield models;
- The historic research trials and the FGYA's nutrition trial are being used to monitor responses of managed stands to more intensive management practices, and also to validate growth and yield models;
- Permanent sample plots belonging to FGYA members are being used to monitor how stands respond to mountain pine beetle attack.

Jack Wright, a pioneer in the application of growth and yield to forest management planning, assesses a young pine stand (1981).

FUTURE DIRECTIONS

The next five years will see not only continued cooperative research by the Association, but also operational application of the knowledge gained by its members over the last decade.

1. Continued Research

A - Development and management of the association

As the FGYA looks forward to the next five years, the shared research program will continue to be focused on meeting the information needs of the membership, co-operatively and cost-effectively. To ensure that this need is met, the Association will expand its extension and communication activities, placing an increasing emphasis on developing and providing decision support information and tools for the management of risk and change in lodgepole pine. This effort will be most effective if members and other users of the information and tools are encouraged to provide review and feedback on the utility and value of our products.

B - Regenerated Lodgepole Pine Trial

The Association will continue monitoring the growth of lodgepole pine regenerated after harvesting, under various management regimes. During the next five years, this monitoring program will follow the young pine through to completion of the regeneration phase of stand development, the first such trial to do so in Alberta. The results will be used to enhance and expand the preliminary regeneration model, replacing current interim projections to performance survey age with irrefutable empirical data. This will provide a strong and valuable basis for setting and forecasting performance against regeneration targets, calibrating reforestation standards, and selecting appropriate treatments and strategies for their successful achievement.

The trial was designed for continued monitoring of stand development during the growth phase following regeneration. In order to allow for tracking and evaluation of growth under a wide range of site and stocking conditions, the Association through its member company co-operators will conduct scheduled thinning treatments of designated plots. The thinning will complete the full set of controlled treatments included in the original experimental design.

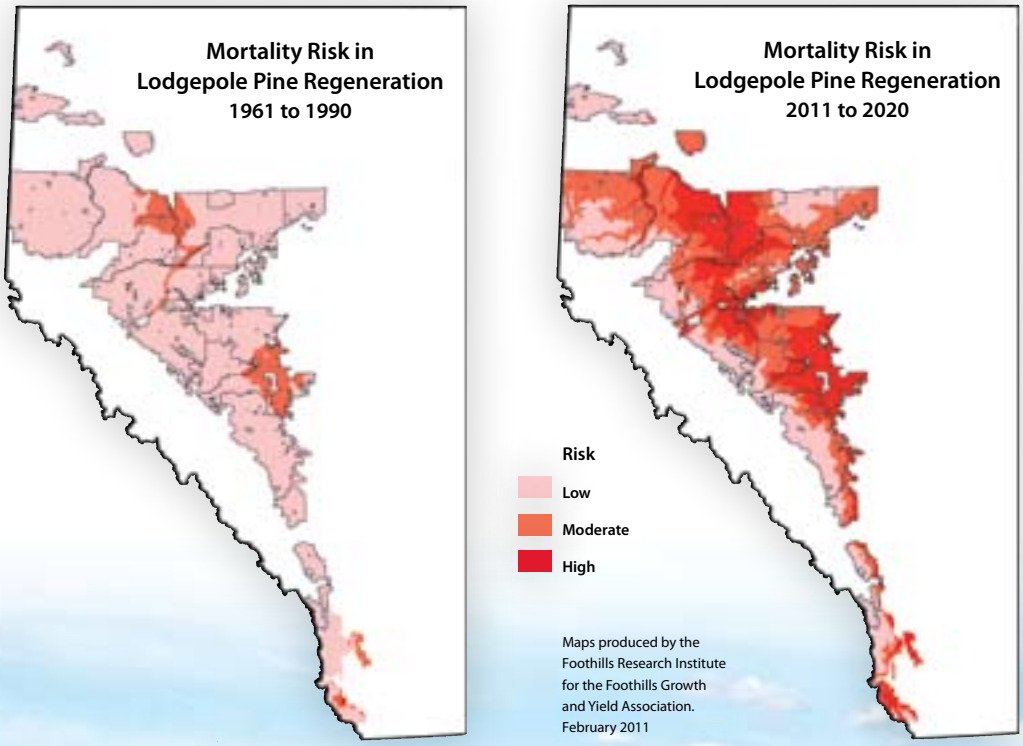
Strong linkages already identified between site, climatic factors and the health and mortality of lodgepole pine will be further examined over the next five years, with the development of improved and map-based tools to predict mortality and health risks. These will be of high value to silviculturists and planners developing strategies and standards for reforestation under Alberta's changing environmental conditions. See Figure 11.

Dave Presslee (1950-2000), an avid supporter of forest research, in a 35 year old regenerated pine stand, 1998.

C - Comparison of pre- and post-harvest stand development

Observations and results from the last 10 years, some of which were based on comparisons between similar-age fire-origin and post-harvest stands, will be validated by ongoing monitoring of the growth of regenerated and managed stands. Of particular interest are the trends towards higher productivity observed in managed stands, apparently resulting from control of density and stocking.

Figure 11. Changing risks of regeneration mortality in the forest management areas of FGYA members. Mapping where risks of adverse climate effects are increasing will assist managers to develop and apply adaptive silvicultural strategies.



D - Historic research trials

The Association will continue to maintain and monitor such long-term silviculture trials as will be valuable in meeting its information and validation needs. For instance, the Gregg spacing trials are proving invaluable for explaining and validating the trends observed in comparisons of pre- and post-harvest stand development mentioned above, and for testing available growth and yield models, most of which have relied primarily fire-origin stand data for their development.

We will assist the Canadian Wood Fibre Council of the Canadian Forest Service in assessing the effects of management practices on wood quality.

E - Yield estimation

The Association and its partners will renew activity under this project to validate growth and yield models for use in the Foothills region, and look at appropriate enhancements to improve their value. It proposes to also improve and extend the linkage between regeneration forecasting tools and conventional growth and yield models predicting rotation-age yields.

F - Enhanced management of lodgepole pine

The Association will complete the analyses and reports of initial trial results commenced with University partners. Subject to further review of these results by members, it will also re-measure the thinning and fertilization field trial and obtain a fuller assessment of yield responses to treatments conducted in 2005-2006.

G - Regeneration management in a mountain pine beetle environment

The Association will continue to monitor mountain pine beetle impacts on its network of 240 permanent sample plots, and examine the research findings of other projects underway in the Mountain Pine Beetle Ecology Program of the Institute. Through this work and collaboration, we will seek to provide improved tools for assessing treatment options for stands attacked by mountain pine beetle. Further, we will encourage and assist the testing and monitoring of treatments to promote regeneration in non-salvageable stands attacked by mountain pine beetle. Ongoing evaluation of post-MPB attack regeneration will improve forecasts as more data become available. Further, improved wood quality parameter forecasts will be developed when research begins to yield data in the next one- to three years.

2. Operational Application

The commitment of FGYA members to long-term projects over the last decade is now bearing fruit. Although a single decade represents only a fraction of the rotation required to grow lodgepole pine in Alberta, the work done by the Association since its inception 10 years ago has yielded results and knowledge that are ready for operational testing and application. The next five years will see the acquired knowledge "hitting the ground" as members test, apply and ultimately incorporate it into their own operations.

In 2011 at least one member company will commence a pilot operational testing program of modifications to silvicultural practice, based on the Association's regeneration research. This will hopefully provide a model for others to follow.

Changes to silvicultural practice under consideration include increased reliance on natural regeneration and reduction of pathogen threats, supported where necessary by modifications to site preparation, site and stand survey procedures, species selection, tending prescriptions and deployment of seed and planted stock. We expect that all members will utilize, depending on their needs, the regeneration and/or mountain pine beetle decision support tools as these become fully developed and tested over the next five years.

FGYA FINANCIAL REPORT

for the period April 1, 2000 to March 31, 2010

	2000	2001	2002	2003	2004
Opening Balance	90,000	74,999	93,408	96,508	120,071
Industry Fees Direct	0	20,000	46,593	30,000	30,000
SRD Contribution	0	0	10,000	0	0
FRIAA Funding	50,000	70,000	105,000	148,407	94,500
In-Kind Plot Measures Establishment	0	440,500[2]	220,450	100,600	174,200
Total Income	**140,000**	**605,499**	**475,451**	**375,515**	**418,771**

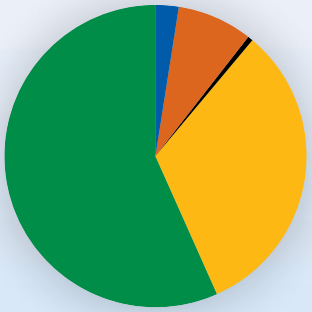
[2] Member companies established and measured RLP plots at their own cost. Totals shown are based on average estimated costs by five year period.

	2000	2001	2002	2003	2004
Office and Computer	0	581	694	2,415	935
Other – Capital	7,191	0	0	0	0
Meetings and Tours	3,177	4,676	22	1,240	461
Rentals, Field Supplies	3,635	50	0	578	0
Travel and Training	998	6,762	9,693	9,465	4,265
Wages and Benefits	0	0	0	0	0
Plot Costs (members)	0	440,500	220,450	100,600	174,200
Consulting Fees	50,000	59,522	148,083	142,161	120,739
Fund Transfers EFM Project	0	0	0	0	0
Recovered Expenses	0	0	0	-1,014	0
Total Expense	**65,001**	**512,091**	**378,943**	**255,445**	**300,600**
Year End Balance	**74,999**	**93,408**	**96,508**	**120,071**	**118,170**

2005	2006	2007	2008	2009	10 Year totals
118,170	116,108	156,392	114,449	88,001	90,000
30,000	22,000	15,000	30,000	37,000	260,593
0	0	0	0	0	10,000
115,500	176,000	120,000	97,500	90,000	1,066,907
143,400	253,800	143,400	253,800	143,400	1,873,550
407,070	**567,908**	**434,792**	**495,749**	**358,401**	**3,301,050**

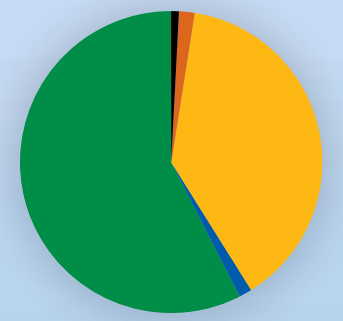
2005	2006	2007	2008	2009	10 Year totals
3,290	4,223	2,275	1,468	1,666	17,549
0	0	0	0	0	7,191
2,539	1,165	4,396	0	1,353	19,029
488	0	0	0	0	4,751
8,048	908	1,257	0	1,312	42,708
29,738	0	0	0	0	29,738
143,400	253,800	143,400	253,800	143,400	1,873,550
103,459	111,421	169,014	143,480	180,242	1,228,121
0	40,000	0	9,000	550	49,550
0	0	0	0	0	-1,014
290,962	**411,517**	**320,343**	**407,748**	**328,523**	**3,271,172**
116,108	**156,392**	**114,449**	**88,001**	**29,878**	**29,878**

FGYA Income
April 1, 2000 to March 31, 2010



- – Opening Balance $90,000
- – Industry Fees (direct) $260,593
- – SRD Contribution $10,000
- – FRIAA Funding $1,066,907
- – In-Kind (plot measurements) $1,873,550

FGYA Costs
April 1, 2000 to March 31, 2010



- – Office, Other, $28,477
- – Meetings, Tours, Training $61,737
- – Field Operations, Research $1,257,859
- – EMLP (Project 6) Transfer $49,550
- – Plot Measurements (members) $1,873,550

Our Partnership

The forest management agreement areas of the nine member companies of the Foothills Growth and Yield Association represent over two million hectares of pine-dominant forest landscapes in Alberta. Alberta Sustainable Resource Development participates in the technical and steering committees of the Association to provide a policy and technical perspective, ensuring the work of the Association is aligned with and contributing to departmental priorities.

Our Staff

Dr. Dick Dempster has been the scientific authority for this program since its inception in 2000 and continues as Research and Development Associate.

In 2007/08 the responsibilities for program direction and scientific management were partitioned into two positions – the Operations Director and Research and Development Associate. Bob Udell has been Operations Director since then, with early backup by Hugh Lougheed of Timberline (now TECO Natural Resource Group) and with continuing support from Sharon Meredith of Alberta Sustainable Resource Development.

Harry Ullrich of Timberline (now TECO Natural Resource Group) served as Field Coordinator in 2007 and Sharon Meredith assumed this role in 2008, with Rand McPherson (the Association's original Field Coordinator) replacing her in 2009.

Bob Udell and Dick Dempster, 2009.

Far right: Rand McPherson Gregg Thinning Trials 2002

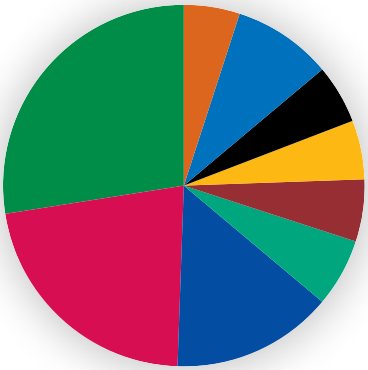
Acknowledgements

Images used in this report came from various sources, including Alberta Sustainable Resource Development, Westsky Resource Consultants Ltd., the Foothills Research Institute, member companies of the Foothills Growth and Yield Association (in particular Hinton Wood Products), staff members of the Association, and professional photographer Brian Carnell. All contributions are gratefully acknowledged.

Maps used in the report were produced by the Foothills Research Institute and we particularly recognize the contribution of Debbie Mucha and Darren Wiens of the GIS Program for their enthusiastic and timely support.

David Holehouse of MediaMatch Communications was the editor of the report, one of his last forestry assignments before closing down his business to move to government service. We will miss his involvement as a long time friend, advocate and skilled communicator for the forestry community. We also appreciate the fine work of John Luckhurst in the design of this report.

Our Partnership:
FGYA Sponsoring members and areas of Lodgepole Pine on their tenures



Member	Net pine-leading area (ha)	% of total
– Alberta Newsprint Company	106,870	5.2
– Blue Ridge Lumber Inc.	180,323	8.8
– Canfor	106,271	5.2
– Millar Western	112,406	5.5
– Spray Lake Sawmills	114,988	5.6
– Sundance Forest Products	121,848	6.0
– Sundre Forest Products	293,655	14.4
– Hinton Wood Products	451,713	22.1
– Weyerhaeuser	557,433	27.2
Total	**2,045,507**	**100.00**

Questions or comments on this 10 Year Report?

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