Evolution of Adaptive Forest Management in a Historic Canadian Forest

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Abstract
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In 1955, North Western Pulp and Power Ltd. hired Desmond Crossley, a distinguished Canadian Forest Service Researcher, to be the Company's first Chief Forester. Crossley set in motion a program of progressive and adaptive forest management wherein science and research would guide the design and implementation of forest management strategies.

The forest management program at Hinton established a new standard for forest management in Canada and continues to be acknowledged as leading edge in the country. After almost 50 years, foresters at Weldwood's Hinton operation continue the science-based adaptive management tradition and ethic. This has led to remarkable advances in the knowledge and practice of forestry on this historic forest.

The challenge of implementing sustainable forest management (SFM) has exerted downward pressure on timber-based allowable annual cuts. Substantial landbase reductions have been taken to implement a comprehensive sustainable forest management program. However, allowable annual cuts have been sustained and increased over time as the sustainable forest management program was being put in place. This was accomplished through timely and ecologically appropriate silviculture, along with leading-edge growth and yield programs.

The non-timber elements of sustainable forest management present new challenges to the forest manager and must also be supported by scientific research, which is wide-ranging and expensive. The applied research program at Foothills Model Forest has contributed greatly to this new knowledge. One of the Foothills Model Forest programs, Natural Disturbance Research, provided the foundation for a new system of forest management at Hinton – Natural Forest Management – that more closely approximates the patterns and processes that formed the forests currently being managed.

Introduction

On March 29, 1949, the Province of Alberta passed a new *Forests Act*, authorizing agreements for growing continuously and perpetually successive crops of forest products. Thus began the Alberta Forest Management Agreement system, a template of sustainable forest management that set a new standard for industrial forest management in Canada.

The St. Regis Paper Company agreed to partner with North Western Pulp and Power Ltd. (NWP&P) to build Alberta's first bleached kraft softwood pulpmill and to develop and implement a sustained yield forest management program on a large committed publicly owned and industrially managed forest. This forest management program set the standard for forest management in Canada. Company foresters worked collaboratively with their Alberta Forest Service colleagues to put into action the principles embodied in the new agreement. After almost 50 years of operations, the program continues to maintain and increase the allowable annual cut from the committed landbase while conserving all the other values found on this spectacular forest at the doorstep of Jasper National Park.

This undertaking was notable for several reasons. It was the first designated forest management area in then largely undeveloped Alberta forests. At 770 square kilometers it was a large area, virtually unroaded and without a forest inventory. The challenge of developing and implementing a forest management program on a very tight schedule with a small staff of eight foresters required innovative approaches and creative planning.

Scientist Designs First System

In the late 1940s and early 1950s, Desmond I. Crossley was a distinguished scientist with the Canadian Forest Service (CFS) and the acknowledged expert in the management and silviculture of lodgepole pine. Increasingly frustrated by his inability as a researcher to see his knowledge reflected in forest practice, and offered the opportunity and authority to take on just such a challenge, he accepted the position of first chief forester at Hinton.[i] Crossley immediately set about gathering a cadre of dedicated and respected foresters with expertise in all aspects of forestry to help design and put in place his vision of a sustainable forest management system.

An Early Approach to Adaptive Forest Management

In 1958, working with his counterparts in the Alberta Forest Service, particularly Reginald D. Loomis who was responsible for forest management, Crossley developed a system of "operating ground rules" that would guide forest operations. Crossley and Loomis also developed and included in the ground rules a definition and philosophy of adaptive forest management decades before it appeared in the popular lexicon of North American forestry:

> *"The cutting system to be adopted on a trial basis will appropriately be some pattern of clear cutting. As many modifications of such cutting systems will be adopted as possible in order, by experiment, to arrive at a system or systems best adapted to the silvicultural requirements of the species in question."*[ii]

With his strong background in research, Crossley encouraged many of his former CFS colleagues to bring their expertise to the Hinton forest and apply research to pressing questions of technical forest management such as silviculture, hydrology, growth and yield. Meanwhile, he urged his own foresters to embark on what he described as "sore thumb research" – ad hoc experiments – to address their own challenges. Since then, scores of research studies in all aspects of sustainable forest management have been pursued on the Hinton forest, particularly increasing over the last decade (Figure 1). In the 1990s, applied research at Foothills Model Forest was used in developing the fifth revision of the Company's original forest management plan – the first to fully implement a sustainable forest management (SFM) system along with quantitative evaluation of the interactions between forestry, wildlife and watershed values. The research supported the successful certification of the first forest in Alberta under the demanding Z809 system of the Canadian Standards Association (CSA), as well as the design and implementation of the Company's new sustainable forest management system, described later.

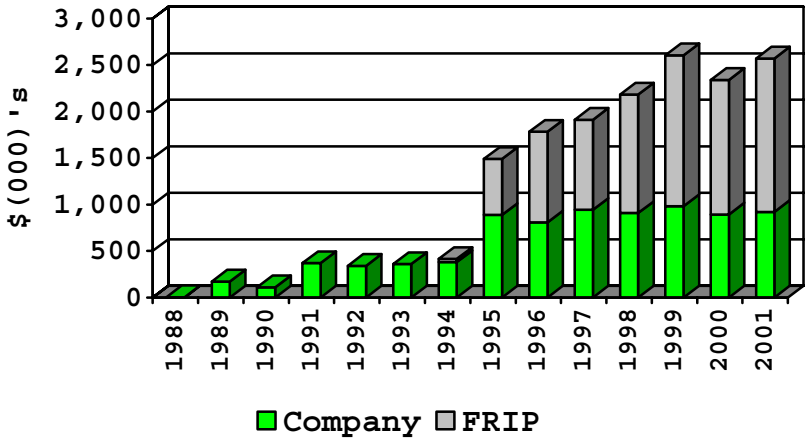

Figure 1. Weldwood direct and sponsored investment in research on the Hinton forest, 1988-2001. The Alberta Forest Resource Improvement Program (FRIP), funded by forest industry contributions, supports research and other activities that are not the regulatory responsibility of forest industry, such as wildlife management.

Silviculture Systems

In 1955, forest operations in Alberta were essentially diameter-limit systems designed for the sawmilling industry. Reforestation was left to natural processes and was not always successful, particularly in lodgepole pine. Crossley, based on his classic research experiments and background, was convinced that clearcutting, combined with site preparation for natural seeding, would be most appropriate for the species most common on the Hinton forest – lodgepole pine and white spruce. This was radical thinking in 1950s Alberta, but the supporting research backed up by the adaptive management principle suggested it was worth trying.

Little technology was available for site preparation, so Crossley and his silviculturists designed their own combination of front-mounted ploughs and spiked anchor-chain drags to prepare sites for natural regeneration. Although this was generally successful, it was not always so, and planting programs began soon after. Frustrated by the poor quality,

survival, and growth of bare-root stock available in Alberta at the time, Crossley hired Bob Carman, an Ontario forester with container-stock expertise, to join the forestry team. Carmen was to design and build a container-stock nursery on site and take over the silviculture program. Carman also introduced a post-harvest silviculture survey system to ensure the best match between site conditions and silvicultural prescription.

Such was the ground-breaking success of this program that Crossley was invited to present a summary of it at the World Forestry Congress in Madrid in 1966.[iii] Later, he tried to persuade the Company to implement a program of intensive forest management, presenting a compelling suite of treatments for increasing the allowable annual cut on the forest.[iv] However, an excess of allowable annual cut over mill needs at that time negated the need for such seemingly expensive measures.

By the late 1990s, Company foresters had continued to modify and improve silviculture systems and were beginning to experiment with the application of traditional European practices, such as shelterwood and selection systems, to the management of highly productive ecosystems in riparian areas of the forest. Furthermore, they were refining their approach to traditional site preparation and planting systems to enhance the establishment and growth of new forest stands. These efforts, combined with enhanced growth and yield analysis of regenerated stand performance, were being reflected in increasing growth performance and allowable annual cuts. An internal proposal for intensified management was developed and implemented by the Company in 1996,[v] facilitated by an enabling environment for such measures under Alberta forest policy.[vi]

Ecologically Based Management

Early Company studies in site classification did not make the link between ecological classification and operational planning. In 1996, with the cooperation of the Company and Foothills Model Forest, Ian Corns of the Canadian Forest Service led a team to develop an ecosite-based system for the model forest land base.[vii] This system was then used to ecologically classify and map the Weldwood forest over the next few years. It became the foundation upon which integrated harvest, reforestation and wildlife habitat plans were developed.

Growth and Yield – Forest Management Planning

Initially, the forest was set up in four sustained-yield management units, each with its own allowable annual cut. Fire-origin lodgepole pine and white spruce stands dominated the landscape. By 1960, the boundaries and ages of these stands were interpreted and ground-truthed to establish a fire-origin age-class map for the forest. In later years, this map would become the foundation for the Foothills Model Forest natural disturbance research initiative. Based on this map and topographic features, the forest was further subdivided into operating compartments for harvest planning and scheduling.

Forest type maps available from the first Alberta forest inventory were not sufficiently detailed for planning, and the Company decided to establish its own detailed forest inventory program. Initially, this was based on a network of 3,000 permanent sample

plots (PSPs) established across the forest area, measured on a 10-year return cycle. Once harvested, a plot was re-established on the reforested stand to track and compare growth rates between the original forest and the regenerated stand replacing it. Over time, more detailed fine type maps and a comprehensive ecological classification and mapping system replaced the PSP inventory system, at which time they were converted to a growth and yield monitoring system. This system is still in use, and is now the largest and most highly regarded single repository of information on the growth and yield of lodgepole pine in North America. From this foundation, Hinton foresters have examined the growth of both fire-origin and regenerated stands to establish technically defensible and validated estimates of growth and yield as the basis for sustainable forest management and allowable annual cut forecasting.

The Company prepared Alberta's first detailed forest management plan in 1960, with three paramount principles:

- Practice sustained yield forest management.
- Schedule the oldest ages first, and get them back into fast-growing regenerated stands.
- Maintain a uniform log haul distance from the woods to the mill over time.

In 1975, Crossley was proud to report successful implementation of this management plan in the first 20 years of progress.[viii] Since then, there have been five updates to this forest management plan, each more sophisticated than the last, and each increasingly incorporating the philosophy and practice of sustainable forest management for all values in the forest. Meanwhile, the forest management program continues to be recognized as a Canadian leader in sustainable forest management.[ix]

It is useful to examine the current status of the forest with regard to the founding principles and today's values.

<u>Practice sustained yield forest management</u>

The size of the productive landbase that contributes to the allowable annual cut has fluctuated over time in response to a number of external and internal influences. Major withdrawals resulted from a surge of oil and gas/ coal mining operations, as well as land set aside for protection or special management, land added for mill expansions (1988), and – with the 1999 forest management plan – an additional 100,000 ha of land set aside or restricted to achieve the goals and objectives of sustainable forest management.

The challenge to maintain allowable cuts through these changing times was only met through timely and appropriate reforestation, and enhanced growth and yield analysis. The latter included permanent sample plot analysis and targeted studies and research initiatives in both fire-origin and regenerated forest stands. In 1985, for example, the company examined the use of growth intercepts[2] for forecasting stand growth and yield[x]. This study showed a substantial increase in regenerated stand performance compared to fire-origin stands (Figure 2). This, combined with the analysis of 3,000 fire-origin and

[2] Growth intercept: the five-year or ten-year height growth above breast height in top height trees (100 largest-diameter trees/ha) in a forest stand.

regenerated permanent sample plots, resulted in a substantial increase in the allowable annual cut. It set the stage for the decision in 1988 to proceed with a major expansion of the pulp mill, and the construction of a new 250 million board foot sawmill.

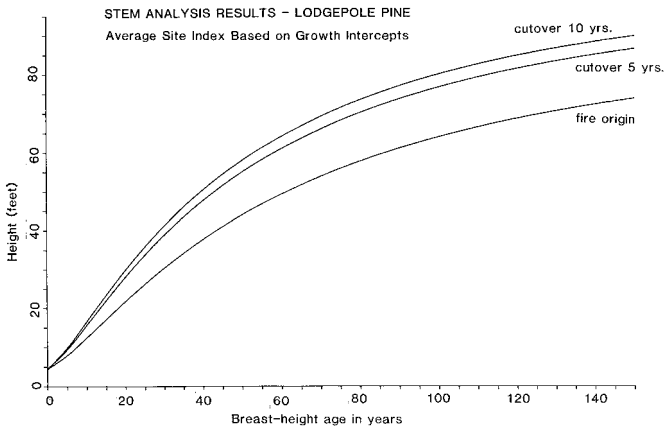

Figure 2. Results of the 1985 study. Stem analysis of fire-origin and regenerated plots showed a substantial increase in growth of regenerated forests. These results were replicated and verified through analysis of permanent sample plots.

In subsequent plans, the per hectare and absolute allowable annual cut has continued to grow as a result of a combination of effective and immediate reforestation and continuing emphasis on a scientifically rigorous growth and yield program (Figure 3). This has been accomplished despite continuing pressures on the landbase dedicated to forestry, coming from such other uses as oil and gas, coal, recreation development and protected areas and – more recently – the sustainable forest management imperative.

Schedule the oldest timber first

A classic approach to normalizing the forest, this principle has been upheld, with some variation for other management priorities, throughout the first few decades of the forest management system. Recently, research under the Natural Disturbance Program of the model forest has been applied to ensure that the amount and distribution of old growth on the landscape remains within the historic range of variability.

Maintain a uniform haul distance

In his 1984 interview, Crossley noted the intent to maintain a 72-km haul distance over time. By 2002, this average haul distance was 69 km and is forecast to remain in that range for the next 200 years.

Integration of Wildlife and Other Values in Forest Management

At a 1982 conference on forestry and wildlife, the Company offered its forest management area as a testing ground for integrated wildlife management. A Company–government working group subsequently elaborated on the concept. In 1988, Weldwood hired Rick Bonar as the first wildlife biologist to become a full-time forest industry employee in Alberta. The Company and the provincial government

agreed that both had important roles to play in wildlife management—the Company would manage the habitat while the government would manage the wildlife itself. Bonar's work, along with the Company's other research activities, contributed significantly to the establishment of the Foothills Model Forest as a major research centre in 1992.

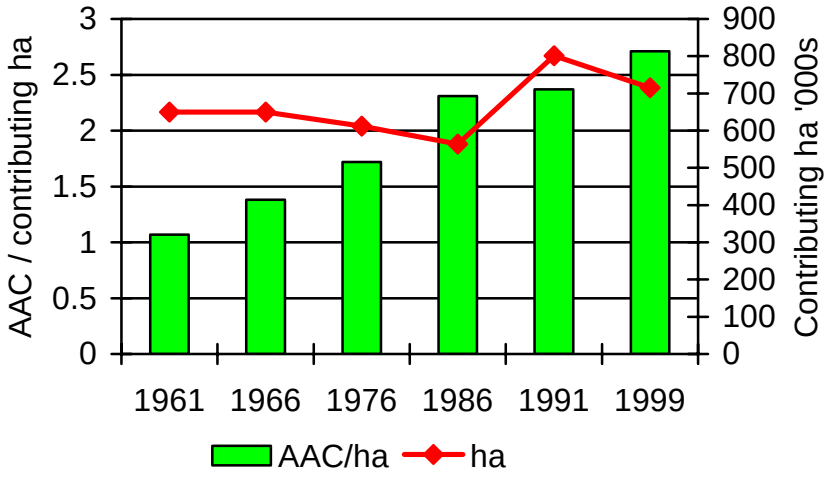

Figure 3. The allowable annual cut (AAC) per contributing hectare has grown with each successive management plan through a combination of prompt and effective reforestation and growth and yield research.

The 1999 forest management plan was the first plan that was able to explicitly reflect and quantify the elements of sustainable forest management in timber supply forecasting. Inventory and planning to address a broad range of values on the forest was exhaustive and groundbreaking (Table 1).

Research by the Company and Foothills Model Forest, among others, was incorporated into the 1999 forest management plan. A quantitative analysis of the effect of the timber supply strategy on wildlife habitat and species response was used to adjust the forest management strategy to maintain viable habitat and populations of all known wildlife species on the Hinton forest over a 200-year planning horizon. A concomitant analysis of hydrologic and other value impacts also affected both the amount of landbase dedicated to timber production and its contributing allowable annual cut. In the end, almost 100,000 hectares were removed from a contributing landbase (1991 plan basis) of 800,000 hectares. This set the stage for successful certification of the Company's landbase to the CSA Z809 sustainable forest management standard. The costs of designing and implementing a sustainable forest management system on the Hinton forest have continued to rise, peaking at $11.4 million in 1999 when the forest management plan was completed (Figure 4).

Table 1.
The Complexity of Inventories for Sustainable Forest Management

1960 forest management plan: "sustained-yield forest management"	**1999 forest management plan: "sustainable forest management"**
Forest inventories (for calculation of sustainable AAC) ➢ Permanent sample plots (Continuous Forest Inventory) ➢ Inventory listing all forest types, based on the Continuous Forest Inventory ➢ Age classes of the forest	*Forest Inventories (for calculation of sustainable AAC)* ➢ Permanent Growth Sample plots ➢ Inventory of forest types based on Alberta Vegetation Inventory ➢ Age classes of the forest ➢ Regenerated stand inventory ➢ Ecological site classification
Additional Inventories for the 1999 Forest Management Plan "Sustainable Forest Management"	
Visual landscape inventory ➢ Basis for developing "visual quality objectives" (similar to B.C. visual landscape inventory)	
Cultural/historic inventory ➢ Basis for protecting sites of unique historic or cultural value	
Seral Stage/ Forest Type classification ➢ Basis for "Natural Forest Management" program ➢ Basis for broad scale/ coarse filter habitat supply	
Riparian corridor inventory ➢ Basis for special management zones ➢ Physical landform (active channel, floodplain, terrace, fluvial slopes, etc.) ➢ Site sensitivity (high, medium, low) ➢ Management access ➢ Management history pre-1956 ➢ Basis for appropriate silviculture design	
Regional Hydrology Study ➢ Catchment basin hydrologic characteristics ➢ Hydrologic "triggers" – i.e. threshold limits of management activities ➢ Hydrologic operations manual (Foothills Model Forest)	
Fish and Stream Inventory ➢ Identify streams with fishery management concerns ➢ Primary use for operational planning	
Wildlife Inventory ➢ Species grouping of 153 habitat-related species into 17 "habitat associations" ➢ 30 representative species selected for habitat supply analysis spanning all 17 groupings ➢ Development of Habitat Suitability Index (HIS) models for 18 species linked to habitat associations ➢ Preparation of habitat inventory from Alberta Vegetation Inventory (AVI) ➢ Habitat yield and change forecasting ➢ Habitat supply analysis models (Critter-cruncher, Wild-weasel, Tribble)	

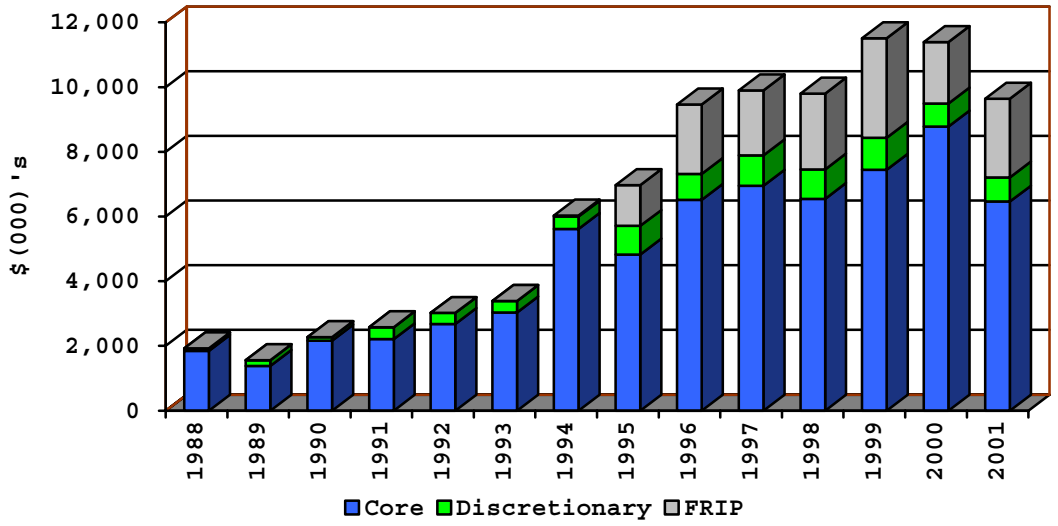

Figure 4. Annual expenditures on all aspects of sustainable forest management continued to rise through the 1990s

Natural Forest Management – the Next Stage in the Journey to Sustainable Forest Management

In 1997, Foothills Model Forest initiated a large, multi-phased study of the role of disturbance in the origin of forest stands in the landscape (Figure 5). As this research progressed, the Company began parallel studies to consider the adaptation of its current management approach to one that more closely emulated the patterns and processes of the natural process of stand renewal (Figure 6). This "coarse filter" approach to forest management has become the cornerstone of the Company's biodiversity management strategy, grounded firmly in sound science.[xi] As the 21st century begins, major changes are underway in harvest design and scheduling (Figure 7) as Weldwood makes the transition to its new forest management system, called Natural Forest Management. These changes include:

- areas set aside for permanent protection
- site specific management interventions in current reserves and buffers
- special management zones in all riparian corridors
- retention of residual patches and individual trees in the harvested landscape
- irregular block shapes and sizes
- road impact reduction.

Research continues, including species-specific research to ensure that "coarse filter" assumptions inherent in the Natural Forest Management approach are reflected in species and habitat responses to on-the-ground practices. Particular challenges have been met in the management of grizzly bear and woodland caribou, species of concern. For both species, special studies have been implemented and specific management treatments developed. The populations and their responses to treatments are monitored and the principles of adaptive management applied. Initial results are encouraging.

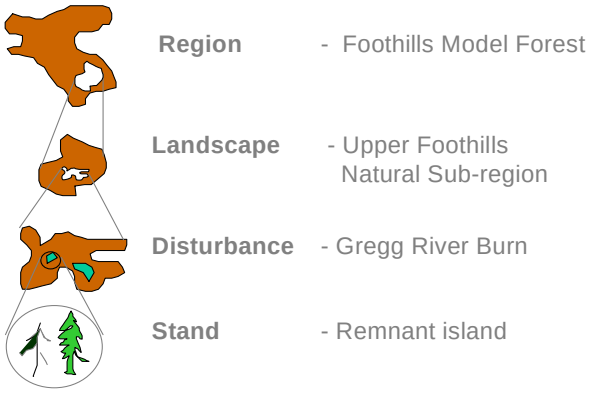

Figure 5. The Foothills Model Forest natural disturbance integrated research program includes many projects, defined by scale.

Figure 6. Fire leaves irregular patterns and remnant unburned or partially burnt areas.

Figure 7. The Natural Forest Management system includes new harvest designs with long-term patch and residual retention, 2001.

Summary and Conclusion

In 1955, Hinton's first chief forester set in motion a program of progressive and adaptive forest management wherein science and research would guide the design and implementation of forest management strategies on the Hinton forest. An early definition of adaptive forest management set the direction for all future management.

After almost 50 years, foresters at Weldwood's Hinton operation continue the science-based adaptive management tradition and ethic established by Des Crossley. This has led to remarkable advances in sustainable forest management for all values of the forest. Despite the negative impacts of sustainable forest management on the sustainable allowable annual cut, a combination of timely and ecologically appropriate silviculture – along with leading-edge growth and yield programs – have sustained and increased the allowable annual cut on this historic forest.

Forest research at Foothills Model Forest has provided the foundation for a new system of forest management – Natural Forest Management – that more closely approximates the patterns and processes that formed the forests currently being managed.[xii]

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