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Forestry and the Forest Industry in the Central Interior of British Columbia

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The forests of BC's central interior range from dry, lodgepole pine dominated forests, to high-elevation cold, wet spruce and sub-alpine fir forests. The forests provide a multitude of resources and support a range of activities including guide-outfitting, trapping, recreation, and timber harvesting. Forest management in the central interior of British Columbia began with the promise of a railway passing through Prince George, and increased dramatically during the world wars and with the establishment of pulp mills in the region. Forestry in the central interior has undergone many changes in legislation and management practices which are summarized for the Prince George, Mackenzie, and Quesnel Timber Supply areas. This paper shows how Crown forest lands are partitioned for resource utilization and discusses the determination and allocation of the allowable annual cut in these areas. Forest land classification and management practices are summarized, and current influences on the landscape, such as the mountain pine beetle, are discussed.

Introduction

In 1793 when Alexander Mackenzie was making his way down the Peace River, he noted in his journals that

> The whole country displayed an exuberant verdure; the trees that bear a blossom were advancing fast to that delightful appearance, and the velvet rind of their branches reflecting the oblique rays of a rising or setting sun, added a splendid gaiety to the scene, which no expressions of mine are qualified to describe. The East

> side of the river consists of a range of high land covered with the white spruce and the soft birch, while the banks abound with the alder and the willow.[1]

Since the early days of the fur trade to present times, forests have provided the economic and cultural mainstay of the non-indigenous people who began inhabiting northern British Columbia in the early 1800s. The first sawmill in the Prince George area was built in 1909 by the Fort George Lumber and Navigation Company (Runnalls, 1946) and was quickly followed by many others. The forest industry took a major upswing when the first pulpmill (Prince George Pulp), owned by Canadian Forest Products, was completed in 1966. In addition to supporting approximately 45% of the labour force (MOF 2001a,b,c), the forests of the central and northern interior support substantial fish and wildlife populations and provide extensive opportunities for outdoor recreation.

The central and northern interior of British Columbia consists of diverse landscapes that include dry savanna-like conditions in the south central interior, interior plateaus and wetbelts, and high-elevation montane forests. Tree species compositions reflect the diverse landscapes with pines and Douglas-fir in the drier ecosystems, hemlock and cedar in the wetbelt, and spruce and sub-alpine fir in the montane and high plateau forests.

In British Columbia there are six forest regions (to be reduced to three regions in 2003) that are administrative boundaries which somewhat reflect major geographic regions and corresponding forest types. These regions are further divided into Forest Districts. Because of the tremendous landscape diversity that occurs in the central and northern interior, and the vast area encompassed by some of these administrative units, this paper will be limited in scope to the area that includes the Prince George, Mackenzie, Quesnel, Vanderhoof and Fort St. James Forest Districts (Figure 1). These form a unit that is west of the Rocky Mountains, not directly influenced by coastal weather patterns, and north of what is generally considered the Cariboo geographic region.

History of Forestry in the Central Interior

Anyone who enjoys exploring the forests of the central interior, particularly around the Prince George area, has probably observed the evidence of early logging in this area. As time goes on, the old sawdust and chip piles, large stumps, and skid roads increasingly blend into the surrounding forest, or are obliterated by new developments. Harvesting of central interior forests began shortly before

Figure 1 Timber Supply Area boundaries in British Columbia. Adapted from the Forestry Handbook for British Columbia, 4th edition, University of British Columbia Forestry Undergrad Society.

the First World War but did not become the driving economic force that it currently is until the Second World War, when demand for wood stimulated the weak northern industry. Prior to the Second World War, most of the market for wood in the central interior came from the Prairies as the population increased and development followed. The promise of a railway that would pass through the Prince George area, then known as Central and South Fort George, resulted in an initial rush of investment in northern mills and businesses. As construction of the Grand Trunk Pacific Railway (now Canadian National Railway) progressed, investment was further fueled by demand for railway ties, and timbers for

bridges and buildings. The Grand Trunk Pacific finally reached Prince George in 1914, just preceding the start of World War I. Lumber production throughout all of BC declined dramatically in concert with the decline in population and labour as a result of the war. Northern mills were hit particularly hard as many had been built on the speculation of utilizing the new railway to meet lumber demands on the Prairies and elsewhere. With the end of WWI, demand for lumber rose again as veterans returned from the war. From 1918 to 1920, the number of sawlogs scaled in the central interior rose from 26 million to 38 million and there were 18 sawmills between Prince George and McBride (Bernsohn, 1981). Investment in the northern industry rose again as the Pacific and Great Eastern railway (now British Columbia Rail) was being constructed south from Prince George and was anticipated to link the north with the south. However, the beginning of the depression caused a decrease in demand for lumber on the Prairies, and a reduction in government coffers. Construction of the Pacific and Great Eastern railway ceased, and the loss of jobs in the forest and railway industries resulted in a population decline as workers went elsewhere in search of work. During this time, and into the depression, many small sawmills went out of business. Lumber production in the Prince George area reached an all-time low of 15 million board feet in 1932, and remained low during the rest of the depression (Bernsohn, 1981).

The start of World War II in 1939 snapped the central interior forest industry out of its slump by creating demand for war-time wood products. Production in the Prince George area jumped to 72.6 million board feet in 1940; new mills sprung up and old ones were re-opened (Bernsohn, 1981). Most of the mills operating in the area were very small and employed only a few men. As the industry expanded and became more mechanized, many of these small mills fell by the wayside or were amalgamated into larger companies. The boom initiated by World War II carried on into the late 1940s, but the driving force behind the industry changed with the arrival of the Pacific and Great Eastern Railway in Prince George in 1952. The railway was eventually pushed north to Fort St. John and Fort Nelson, and opened up new markets and less expensive lumber shipments for central and northern interior mills. A branch line called the Dease Lake extension was initiated in the late 1960s for mining purposes, and was later used by forest companies to access timber in the Takla Lake and Sustut River area, north of Fort St. James.

When Ray Williston became the Minister of Lands and Forests in 1956 (a position he held until 1972), he was not happy with the standards of wood utilization in the industry. Williston proposed some close utilization standards and some performance-based access to wood that would not normally be utilized under the old standards. This, coupled with the government's interest in developing the north, led to expansion of the industry, and modernization of sawmills to handle higher volumes and smaller logs. During the period from the mid 1950s to the mid 1960s, wood production in the Prince George area rose from 380 million board feet to 1250 million board feet, but the number of sawmills fell from approximately 1200 to 400. In addition to mill amalgamation and modernization, industrial expansion at this time included creation of new "Public Sustained Yield Units" (PSYUs) that came with an assured wood supply and a quota system that favoured established operators with good performance records for wood utilization. Williston also developed the Pulpwood Harvesting Agreement in 1961 that was aimed at utilizing wood not used in the sawmill industry. To obtain a PHA, a company had to build a pulp mill, then purchase chips from sawmills or trade for logs that were rated as pulp logs. Canadian Forest Products was the first company to negotiate a PHA in the central interior, and as a result Prince George Pulp began operating in 1966. Prince George Pulp was quickly followed by Intercontinental Pulp (Canadian Forest Products) and Northwood Pulp and Timber in the Prince George area (now part of Canadian Forest Products), and Cariboo Pulp and Paper (Weldwood) in Quesnel. At about the same time, two PHAs were approved by Williston in the Mackenzie area. One was owned by BC Forest Products (now Pope and Talbot Ltd.), and the second by Finlay Forest Industries (now Abitibi-Consolidated). Finlay built the first groundwood pulp mill in the Province. The town of Mackenzie sprang up seemingly overnight as housing was required for the people who worked the mill.

The industrial expansion in the central interior ended in the early 1970s as a result of depressed lumber prices, mill modernization, labour disputes, and increased stumpage rates. It became apparent that changes were needed in the industry, so in 1975 a Royal Commission on forestry was launched, with Peter Pearse as the Royal Commissioner. The Pearse Commission report was released in 1976 and it resulted in a new *Forest Act* in 1978. The new act had some significant impacts on the central interior. Public Sustained Yield Units (PSYUs) were combined with other provincial forests to make Timber Supply Areas (TSAs) within which tim-

ber harvesting quotas were allocated by volume rather than by specific areas to be harvested. This chapter discusses three TSAs: Quesnel, Prince George, and Mackenzie. New tenure types were created, the most significant of which was the Forest Licence—a volume-based tenure with a 15-year term renewable at five years. Another significant change in the new *Forest Act* was a provision that allowed the Ministry of Forests Regional Manager to enter into agreements for the production of tree seedlings.

In 1980–81, there were several tree seedling nurseries established within the central interior. Industrial Forestry Service Ltd. established a nursery at Ness Lake near Prince George, which currently produces 12 million seedlings per year. Ruff's nursery, near the airport in Prince George, was also established at this time, with a current annual production of 8 million seedlings. Northwood initiated a transplant nursery next to Highway 16 west, and the Willow River in 1981, then moved the nursery to their mill site in Prince George in 1985. In the Quesnel area, Blue Collar Silviculture, a local silvicultural contractor, established a nursery in 1985, and later changed the name to Hi-gro Silva Nursery. Prior to the establishment of these private nurseries, the Ministry of Forests had a nursery south of Prince George at Red Rock, established in 1966. This nursery was privatized in 1987, and, along with several other government nurseries, was purchased by Pacific Regeneration Technologies. As a result of the establishment of these private nurseries, seedling production increased dramatically in the Prince George region. Much of this production was aimed at providing seedlings for "backlog reforestation", or the restocking of previously harvested areas. The number of seedlings planted in the Prince George Forest Region increased fourfold from 1981 (24 million) to 1994/95 (95 million) (Bartlett 1996).

Despite improved efforts at reforestation, and a commitment by the Ministry of Forests to long term sustained yield of the timber supply, there was growing public concern over forestry practices, even in the central interior where the economy depended on the timber industry. Local and international concern resulted in the British Columbia Forest Resources Commission, which was asked to "examine the state of the province's forest land base and recommend improvements to the way it is managed"[2]. The Commission's report, released in 1991, made several major recommendations which were acted on by the Provincial government. These included a recommendation for comprehensive, multi-tiered land use planning that involved the public. Implementation of this recommendation in the central interior resulted in the Prince George,

Vanderhoof, Fort St. James and Mackenzie[3] Land and Resource Management Plans, as well as the Cariboo CORE (Commission on Resources and Environment).

The Commission also recommended the establishment of a single, all-encompassing code of forest practices that would govern all aspects of forest management. *The Forest Practices Code Act* was introduced in 1995 and resulted in substantial changes to the forest industry across BC. The Act was amended in 1997-98 to reduce the amount of red tape and to put more of the onus of good forest management on the shoulders of professional foresters.

Forest Land Classification

British Columbia has a unique forest classification system that was initially developed by Vladimir Krajina (1965) then by Pojar et al (1987). Called the Biogeoclimatic Ecosystem Classification system (BEC), it was developed to organize ecological information and management experience and to provide a common language regarding forest sites. The system is heirarchical and combines three classifications: climatic, vegetation, and site (based on soil moisture and nutrient regimes). Biogeoclimatic zones represent groups of ecosystems under the influence of the same regional climate. Each biogeoclimatic subzone has a distinct climax plant association on what is termed a zonal site. These sites have deep soils and mid-slope positions such that they are in the middle of the range of moisture conditions from wet to dry. In other words, it is assumed that what grows on the zonal sites reflects the regional climatic conditions of the subzone. Within any subzone, variations in soil factors (e.g., nutrient status) and topographic conditions affect soil moisture and thereby influence the climax vegetation. Therefore, subzones have sequences of related ecosystems that vary from wet to dry sites. Any given subzone can cover large regions of the province and, therefore, can contain considerable geographic variation. The subzone variant allows for this variation by describing areas that have some consistent variation in climate, for example the area may be generally colder, with fewer frost-free growing days, than other parts of the same subzone. All of British Columbia has been classified into subzones and variants. The most commonly used units of classification for the purposes of forest management decisions are site series that occur within a subzone or variant. Site series are defined by climax (or late successional) vegetation and site properties. Many forest management decisions use the information contained within a site series classification. For

example, Silviculture Prescriptions involve determining, before harvest, the type of silviculture system to use (clear cut and plant, partial cut, etc.), the species to establish as regeneration, the season of harvest, and many other management decisions.

The central interior is dominated by the Sub-boreal Spruce zone, with the Engelmann Spruce–Subalpine Fir zone occupying higher elevations, and the Interior Cedar Hemlock zone along the wetbelt in the foothills of the Rocky Mountains. There is also a small section of the Sub-boreal Pine-Spruce zone in the southwest portion of the central interior (Figure 2). A brief description of each of these zones follows (from Meidinger and Pojar, 1991):

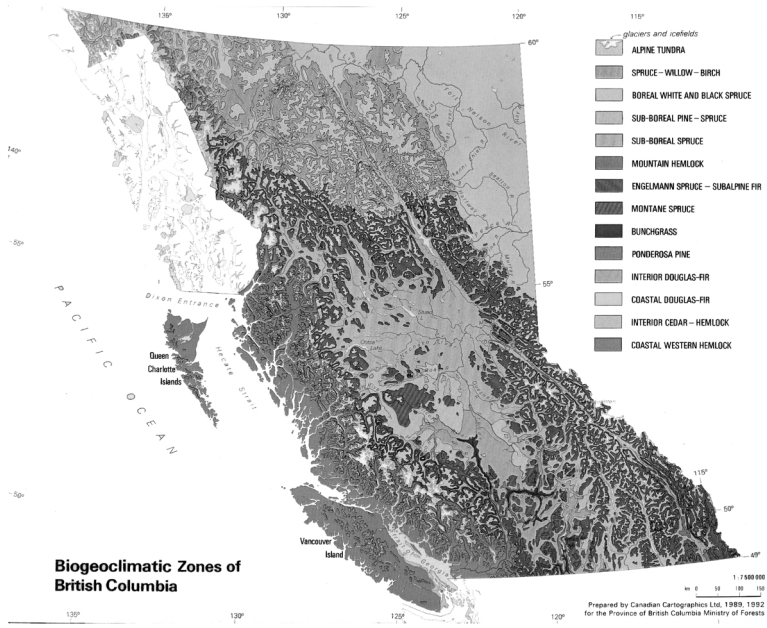

Figure 2 Biogeoclimatic Zones of British Columbia. From Meidinger and Pojar, 1991.

Sub-boreal Spruce (SBS)

The SBS covers a large portion of the centre of BC. It is a montane zone that occupies the Nechako and Fraser plateaus and the Fraser basin. Elevations typically range from 1100 m to 1300 m. This zone typifies climate extremes from severe, snowy winters to very warm, moist, but short summers. Hybrid white spruce *(Picea glauca* x *engelmanniii)* and sub-alpine fir *(Abies lasiocarpa)* dominate

the climax forests. In the drier parts of the zone, lodgepole pine *(Pinus contorta* var. *latifolia),* trembling aspen *(Populus tremuloides),* and paper birch *(Betula papyrifera)* are common seral species.

Moose are the most common species of ungulate in this zone, and they are well adapted to the severe winters with long legs and large bodies. Smaller mammals, such as deer mice and snowshoe hares are also common, as well as the predators of these species: gray wolf, fisher, and marten.

Engelmann Spruce–Subalpine Fir (ESSF)

This zone occurs in mountainous terrain or on the highest elevations of the Interior Plateau. It typically is above the ICH and the SBS, and the climate is cold, moist, and snowy. The growing season is short and winters are long and cold. Tree species in the ESSF reflect these harsh conditions, with Engelmann spruce *(Picea engelmannii)* and sub-alpine fir the predominant species. Forests in the ESSF are usually uneven-aged and relatively open indicating an infrequent fire-return interval and the harsh environmental conditions.

The ESSF is home to species that are not only adapted to cold, snowy winters, but also to the steep terrain. Moose, mountain goat, caribou, and mule deer are found throughout the ESSF, although moose will usually migrate to the SBS or other zones during winter. The ESSF provides very important habitat for Caribou because of their exclusive reliance on the arboreal lichens that are the trademark of mature ESSF forests. Grizzly bears are also common, as well as furbearers such as marten, fisher, red squirrel, and wolverine.

Interior Cedar Hemlock (ICH)

The ICH is a low to mid-elevation zone that is found primarily in southeastern BC but extends up the Robson Valley into the central interior. Commonly called the wet-belt, the climate in this zone is influenced by easterly moving air masses that collect moisture as they travel across the province, then release the moisture as the air mass rises up over the Rocky Mountains. Much of this falls as snow; winters in the ICH are cool and wet, with warm relatively dry summers. Snowmelt during the spring and into the summer provides a steady input of soil moisture making this zone the most productive in the central interior. The milder climate also makes this zone one of the most diverse with western red cedar and western hemlock the dominant climax species. White spruce *(Picea glauca)* and Engelmann spruce, and their hybrid, as well as subalpine fir are also common. Lodgepole pine, birch, and trembling aspen are common seral species.

Wildlife in this zone are adapted to the deep snowfall or migrate in order to avoid it. Grizzly and black bears are the most common large mammals. Caribou are found infrequently throughout the ICH in late summer and early fall before they migrate up in elevation to the ESSF for the winter. The long fire-return interval of this forest type provides old trees and many in various stages of decay. Cavity nesting species are commonly found utilizing these trees throughout much of the ICH.

Sub-boreal Pine–Spruce (SBPS)

This is a montane zone that occurs on the Fraser and Nechako plateaus. Elevations range from 850 m to 1300 m in the north and 1100 m to 1500 m in the south. Winters are typically cold and dry with cool, dry summers. The landscape is dominated by upland coniferous forests with lodgepole pine as the predominant species. White spruce and trembling aspen are also common. Fire is thought to be the primary disturbance agent and the landscape patterns reflect a fairly frequent fire return interval.

As with most of the northern and central interior forests, common wildlife species are those that are adapted to, or avoid, the long, cold winters. Moose, caribou, and black bears are the most common large mammals. This zone is also home to large numbers of waterfowl, which take advantage of the frequent wetlands. The extensive pine forests provide habitat for seed-eating species and their predators but do not support ungulate populations due to low forage production.

As discussed above, forest managers use the biogeoclimatic ecosystem classification system as a site-specific ecosystem classification tool that assists with decisions regarding management activities. The introduction of the *Forest Practices Code of BC Act* in 1995 provided another multi-scale tool that is used to promote sustainability of natural ecosystems. This tool is the natural disturbance type classification system. Forest companies are now mandated to manage the forest for many values, including biodiversity. This is the diversity of organisms in any given area and includes species diversity, genetic diversity, and ecosystem diversity. The underlying assumption to the natural disturbance type classification system is that if ecosystems are managed by processes that are similar to those that maintained them historically, then the native species are most likely to be maintained. These processes include natural disturbances as well as those used by aboriginal peoples, such as burning. To facilitate this, forested areas within the province have

been classified within five natural disturbance types that are used to develop biodiversity objectives.[4] These are:

NDT1—Ecosystems with rare stand-initiating events
NDT2—Ecosystems with infrequent stand-initiating events
NDT3—Ecosystems with frequent stand-initiating events
NDT4—Ecosystems with frequent stand-maintaining fires
NDT5—Alpine Tundra and Subalpine Parkland ecosystems

Natural disturbances range from single-tree, or small group "gap" mortality, to large scale, sudden events that kill an entire stand of trees. Gap formation can occur slowly, for example through infection of trees by root disease or decay fungi, or quickly by bark beetle attack, or isolated windthrow or breakage.

These natural disturbance types are linked to a series of attributes that assist foresters in making recommendations regarding forest management. The type and frequency of natural disturbances in forested landscapes is dependent on climate which influences fire frequency and size, distributions of biotic agents of disturbance, and distribution of tree species. Therefore, each NDT is composed of a specific series of biogeoclimatic subzones that have a common set of natural disturbances. The species composition and structure (age of the trees) in individual stands is determined by the type and frequency of natural disturbances. At the landscape scale, the pattern of these individual stands, and the frequency of different seral stages, is also determined by natural disturbances.

The central interior of BC is dominated by NDT3 at the lowest elevations in the western part of the region, with NDT2 and NDT1 at higher elevations and into the interior wetbelt. NDT5 is found within this region but only at the highest elevations (Figure 3). Therefore, fires are considered the primary disturbance agent in the western part of the central interior region. In the eastern and higher elevation areas, fires have less influence on landscape pattern than do other agents (e.g., root diseases and bark beetles) which generally cause disturbances on a smaller scale.

For purposes of reforestation, biodiversity objectives, and other ecologically based objectives, the biogeoclimatic zone classification and natural disturbance type systems are used. For timber management purposes, such as allocation of cutting rights, a regional geographic structure is used to divide the province into smaller units. As already mentioned, administration is carried out by Forest Districts and Forest Regions. Allocation of harvest volume is based on Timber Supply Areas that are comprised of one or more Forest Districts. The part of the central interior covered by this chapter has three TSAs: the Mackenzie TSA, comprised of the

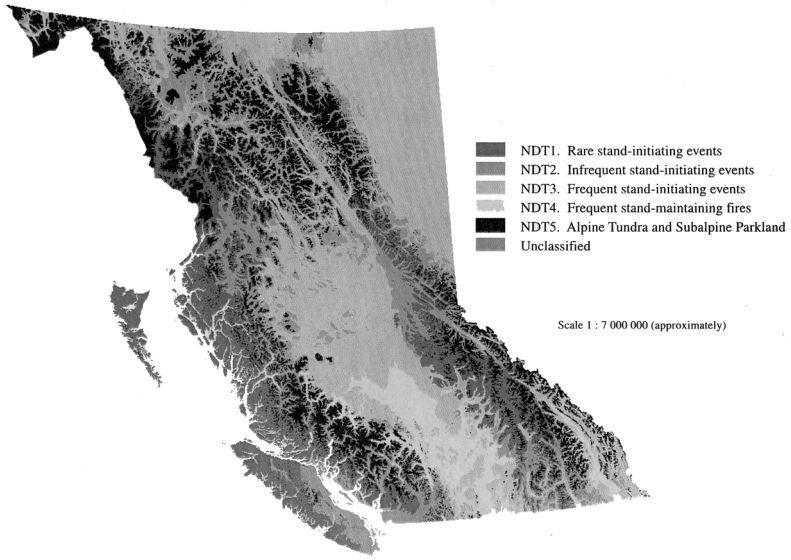

Figure 3 Natural Disturbance Types of British Columbia. From the BC Ministry of Forests, Biodiversity Guidebook, 1995.

Mackenzie Forest District; the Prince George TSA, comprised of the Prince George, Vanderhoof and Ft. St. James Forest Districts; and the Quesnel TSA comprised of the Quesnel Forest District. Excluded from the area encompassed by TSAs are Tree Farm Licences that are a form of tenure based on a specific geographic area.

Prince George Timber Supply Area

The Prince George TSA is 7,508,191 hectares in size of which 71% is considered productive forest. The current timber harvesting land base is 45.1% of the total due to reductions for non-merchantable forest types, environmentally sensitive and inoperable areas, and other factors (Figure 4).

A diversity of landscapes exists within the TSA, from mountain ranges in the east and west, to uplands and plateaus in the central portion of the TSA. The Nechako and Fraser River Basins are a predominant feature of the landscape. Much of the area is occupied by the Sub-Boreal Spruce biogeoclimatic zone with pine, spruce and sub-alpine fir the major coniferous species. Mature trees (over 120 years old) dominate the age class structure as seen in Figure 5.

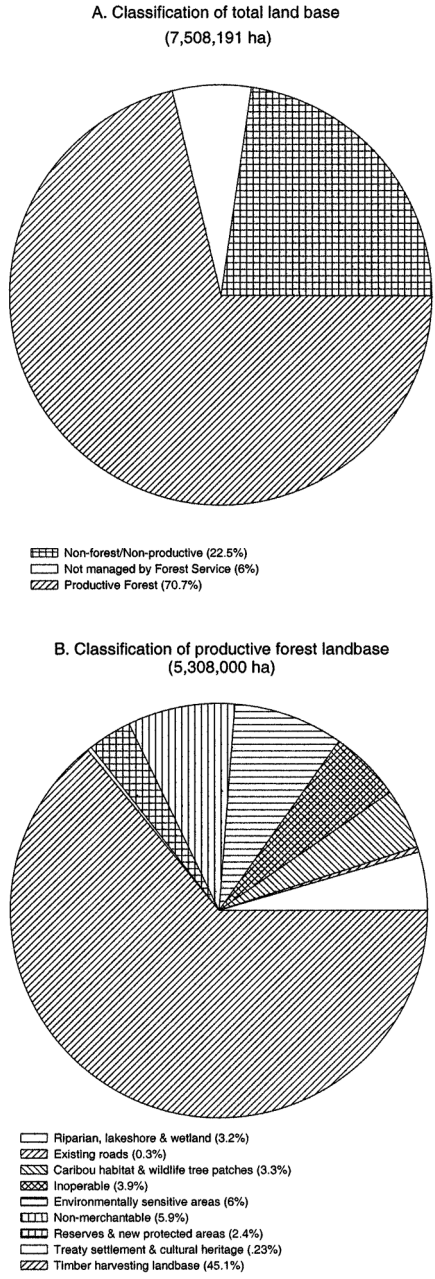

Figure 4 Total land base and harvestable land base of the Prince George Timber Supply Area. Adapted from the Prince George TSA Timber Supply Analysis, 2001. BC Ministry of Forests.

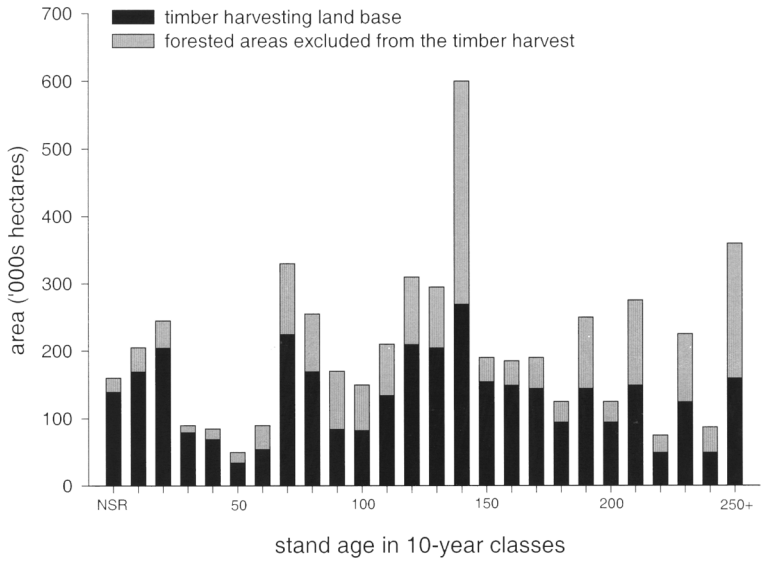

Figure 5 Age class structure of trees in the Prince George Timber Supply Area. Prince George TSA Timber Supply Analysis, 2001. BC Ministry of Forests.

The Prince George TSA's allowable annual cut (AAC) is 12.2 million cubic metres, which is the largest AAC of any TSA in the province. This AAC includes 3 million cubic metres temporary increase aimed at controlling a severe mountain pine beetle *(Dendroctonus ponderosae)* in the area. A telephone pole is approximately one cubic metre, and logging trucks carry about 30 cubic metres. Therefore this volume can be visualized as 410,000 truck loads of telephone poles. Approximately 12% of the provincial harvest occurs in this TSA, and the harvest supports 19 sawmills, two pulp mills, one pulp and paper mill, two chip mills, one pole producer, one veneer plywood mill, and a few value-added wood processing operations.

The dominance of forestry as the primary economic force in the Prince George TSA is evident in employment statistics that indicate logging, forestry services and forest products manufacturing are directly responsible for 45% of the labour force (MOF 2001a). According to the 1995 Socio-Economic Analysis for the Prince George TSA (ARA 1995), there are other forest resource uses that contribute to the economy of this area. There are 44 guide-outfitters licensed to operate within the TSA and annual economic impact is approximately $1.5 million in revenues and 42 person-years of

employment. An important sockeye and chinook salmon resource originates in this TSA (e.g., the Stuart River run) and is estimated at $40 million in value. In addition to the commercial fishery, sport fishing has become the leading outdoor recreation activity with a number of sport-fishing lodges that cater to non-local users. The forests of this region are also popular for other outdoor recreation activities such as camping, hunting, boating, horse-riding, hiking, cross-country skiing, snowmobiling, mountain biking, caving and mountaineering (MOF, 2001a).

The Mackenzie Timber Supply Area

The Mackenzie TSA is 6.4 million hectares in size, and is located in the Arctic watershed of the Peace River. The Rocky Mountain Trench runs north-south through the centre of the TSA, with the Williston Reservoir blocking a portion of the Peace River to create Williston Lake. The TSA is bounded to the east by the Rocky Mountains and to the west by the Omineca Mountains. Much of the TSA is occupied by the Alpine Tundra biogeoclimatic zone, and these areas are largely unforested. The Sub-boreal Spruce and the Engelmann Spruce-Subalpine Fir zones occur in the southern part of the TSA, with the Boreal White and Black Spruce zone in the north. The harvestable land base is estimated at 1.45 million hectares, or 22.6% of the total land base (Figure 6). The allowable annual cut for the TSA is 3 million cubic metres, and is based on the dominant conifer species: lodgepole pine, spruce and true-fir.

The Mackenzie TSA is overwhelmingly dependent on the forest industry for employment. The town of Mackenzie would not exist had BC Forest Products (now Pope and Talbot Ltd.) not established a company town in 1965 to house workers at its mill complex. Over 70% of employment in the TSA is directly or indirectly dependent on the timber industry. The Public Sector makes up 17% of the total employment, with construction, tourism, agriculture and mining accounting for 14%.

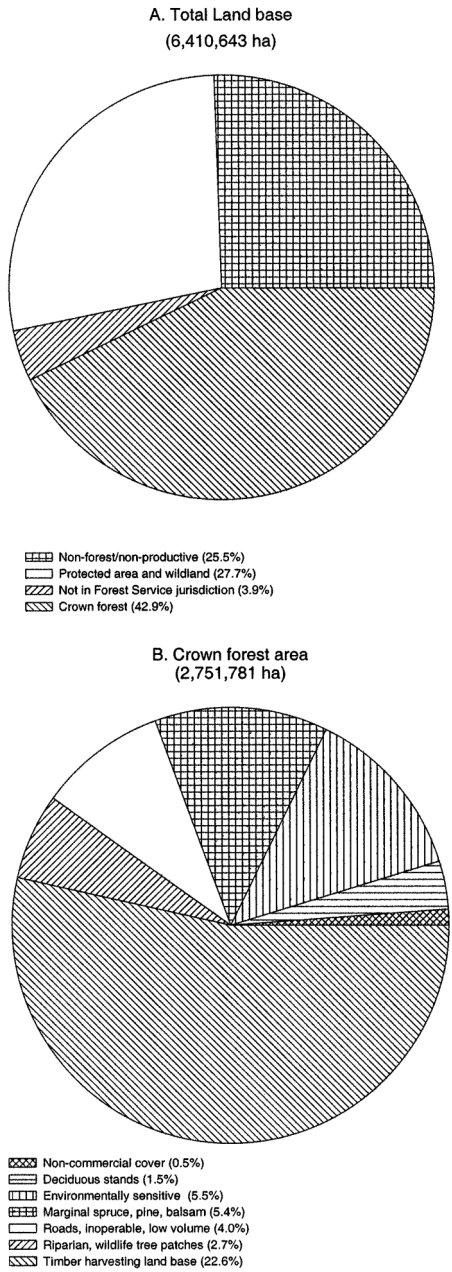

Figure 6 Total land base and harvestable land base of the Mackenzie Timber Supply Area. Mackenzie TSA Timber Supply Analysis, 1995. BC Ministry of Forests.

Quesnel Timber Supply Area

The Quesnel TSA is in the Cariboo Forest Region, and encompasses the Quesnel Forest District. The entire TSA is approximately 1.6 million hectares and has an AAC of 3.25 million cubic metres which is almost 1 million cubic metres higher than the last AAC in order to respond to a serious mountain pine beetle epidemic. When non-commercial forest types, environmentally sensitive areas, and other inoperable areas are removed from the total area, the harvestable land base is just over 1 million hectares (Figure 7). The predominant merchantable species is lodgepole pine (85% of Crown forest stands are composed primarily of lodgepole pine), with spruce, sub-alpine fir and Douglas-fir as minor components. West of the Fraser River, the forests are relatively dry, and dominated by lodepole pine with some Douglas-fir. East of the Fraser River, the forests are wetter, due to the effect of the Cariboo Mountains, and contain more spruce and sub-alpine fir.

The forest and forest products industries account for approximately 65% of employment within the TSA. Employment in the supplies and services sector, and the public sector, are the next most significant, followed by tourism (7% of employment), and agriculture and mining. The area within the Quesnel TSA is popular for outdoor recreation activities including fishing, hunting, cross-country skiing, sled dog racing, and snowmobiling. Tourism is viewed as a likely area of growth by those living in the region.

Forest Management

Legislation governing forest management

During the early, pioneering period of forest harvesting in British Columbia, three policies were established which continue today and are the foundation for current forest management legislation:

- Crown Ownership. In 1865, a Land Ordinance was passed that established Crown ownership of land. As a result, 95% of forest land is currently owned by the Crown and rights to harvest are allocated by different forms of tenure. British Columbia's tenure system is unique worldwide.
- Reservation of Revenue Rights. The Crown had retained the right to revenue from harvesting of Crown timber. Such revenue is primarily in the form of stumpage (a charge per unit volume of harvested timber).

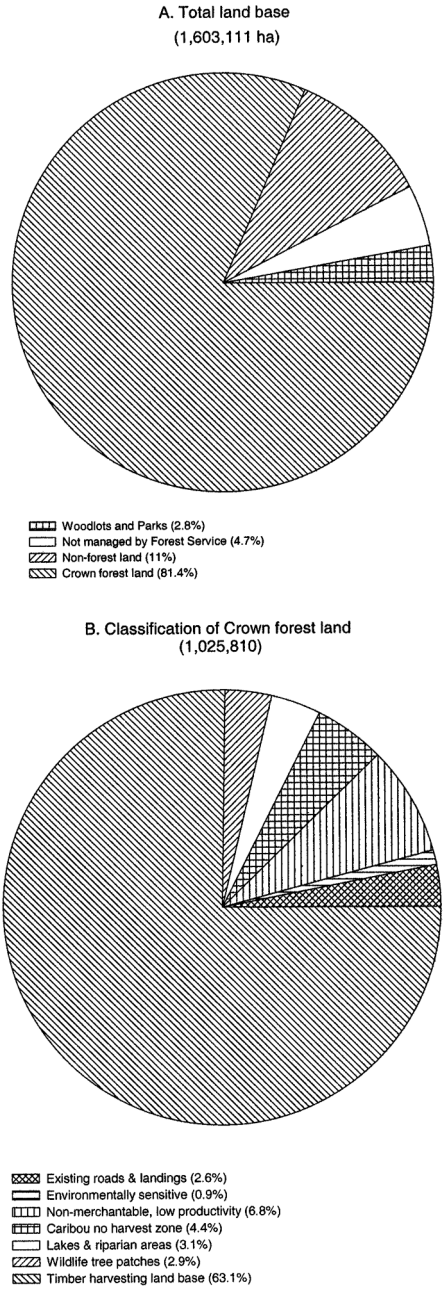

Figure 7 Total land base and harvestable land base of the Quesnel Timber Supply Area. Quesnel TSA Timber Supply Analysis, 1994. BC Minstry of Forests.

- Manufacturing Condition. This requires all non-exempted timber harvested from Crown land to be manufactured in the province.

Forest management in British Columbia is governed by a series of acts, regulations, and administrative documents. Two acts are of particular importance: the *Forest Act*, which governs tenures, harvest rates, stumpage, and other timber harvesting issues; and the *Forest Practices Code of BC Act*, which governs planning, forest practices, and forest protection.

There are several forms of tenure that provide licensees with rights to cut timber. Each license has different requirements and responsibilities. The most common forms of tenure in central BC are listed below, with summary information.

(i) Tree Farm License (TFL). This license provides the right to harvest an annual allotment of timber from a specific geographic area. The area includes Crown and private lands, and the tenure is for 25 years. Most TFL licenses can be replaced every five years. The Crown collects revenue in the form of stumpage, and the licensee is responsible for planning and reforestation.

(ii) Forest License (FL). This license provides the right to harvest a specific volume of Crown timber from an area within a specific Timber Supply Area. The term of the license is 20 years or less, and can be replaced every five years. The Crown collects revenue from stumpage payments, and reforestation is the obligation of the licensee.

(iii) Woodlot License (WL). Similar to TFLs, these licenses provide the right to cut timber from a specific geographic area. The license is granted for a maximum of 15 years and can be replaced every five years. To be eligible for a woodlot license, potential licensees must have private land they are willing to contribute to the woodlot. The Crown collects revenue from stumpage, and the licensee is responsible for planning and reforestation. These are generally small areas (less than 800 ha in the interior) and are usually held by individuals.

(iv) Small Business Forest Enterprise Program. This program involves the sale of timber harvesting rights to individuals and corporations. The objectives of the program are to provide access to timber for small companies, support value-added industry and diversification, market timber through competitive bidding, and emphasize high forest management standards. Timber is sold in the form of Timber Sale Licenses (TSL) that provide the right to harvest a defined parcel of Crown land. The Crown receives revenue in the form of stumpage and "bonus bids" which are amounts of

money that exceed the stumpage rate set by the Crown. The obligation for reforestation rests with the licensee for licenses with large annual cut volumes (>10,000m^3), and with the Crown for smaller licenses.

A list of forest tenures for each TSA is provided in Table 1 (MOFa,b,c). In addition, there are five Tree Farm Licenses in this area listed in Table 2.

Public forest lands in BC provide a diverse array of uses from recreation to timber. The Ministry of Forests is responsible for the management of forest and range resources in provincial forests, whereas the Ministry of Water, Air and Land Protection is responsible for the protection of fish, wildlife, and water resources. The Ministry of Sustainable Resource Management is responsible for land-use planning and coordinating policies necessary for resource development. In determining allowable annual cuts, the Forest Service must analyze different forest types and then consider different management objectives. To do this, the Forest Service divides the landbase into management zones where similar integrated management practices are implemented. These zones reflect different resource management objectives that exist in current management plans. Figure 8 shows summaries of management zone categories for each of the TSAs in the central interior.

All three TSAs have Integrated Management Zones which are areas within the timber harvesting landbase where standard integrated resource management practices apply. Examples of these current practices are "green-up and adjacency constraints" which means that a given area cannot be harvested until the regenerated forest on adjacent harvested areas is at least 2.5 m tall in some Forest Districts, and 3.0 m tall in others.

Visually sensitive zones are also common to all three TSAs. These occur along major highways, and around recreational lakes and rivers. Many of these visually sensitive areas occur within a Local Resource Use Plan area. These plans address issues surrounding non-timber resources within specific areas. They are intended to design management strategies that integrate non-timber and timber resources. In the Prince George TSA there are six LRUP areas. Quesnel has two LRUPs, for the Upper and Lower Blackwater River areas. The area covered by many of these LRUPs was deferred from the timber supply for a period of ten years, after which it will be managed in the same manner as the integrated resource management zone areas.

Table 1 Forest tenures and the apportioned allowable annual harvest in the Mackenzie, Prince George and Quesnel Timber Supply Areas.

Licensee	*Annual Harvest*
Mackenzie TSA	
Sawmills and Pulpmills—Forest Licenses	2.59 million m^3
MOF Small Business Program	47,040 m^3
Temporary Permits	205,940 m^3
Prince George TSA	
Sawmills and Pulpmills—Forest Licenses	6.5 million m^3
Sawmills and Pulpmills—Temporary Forest Licenses	1.02 million m^3
Timber Sale Licenses	5,859 m^3
MOF Small Business Program	1.6 million m^3
Woodlots	100,000 m^3
Quesnel TSA	
Sawmills and pulpmills—Replaceable Forest Licenses	1.45 million m3
Sawmills and pulpmills—Non-replaceable Forest Licenses	384,600 m3
Sawmills—Timber Sale Licenses	5681 m3
Small Business Forest Enterprise	393,000 m3
Woodlots	62,731 m3

Table 2 Tree Farm Licenses and their allowable annual cuts in the central interior

Licensee	*Forest District*	*Allowable Annual Cut*
Canfor	Prince George District	328,000 m^3
Tanizul Timber	Ft. St. James District	160,000 m^3
Dunkley Lumber	Prince George District	239,500 m^3
West Fraser Mills	Quesnel District	400,000 m^3
Weldwood	Quesnel District	122,800 m^3

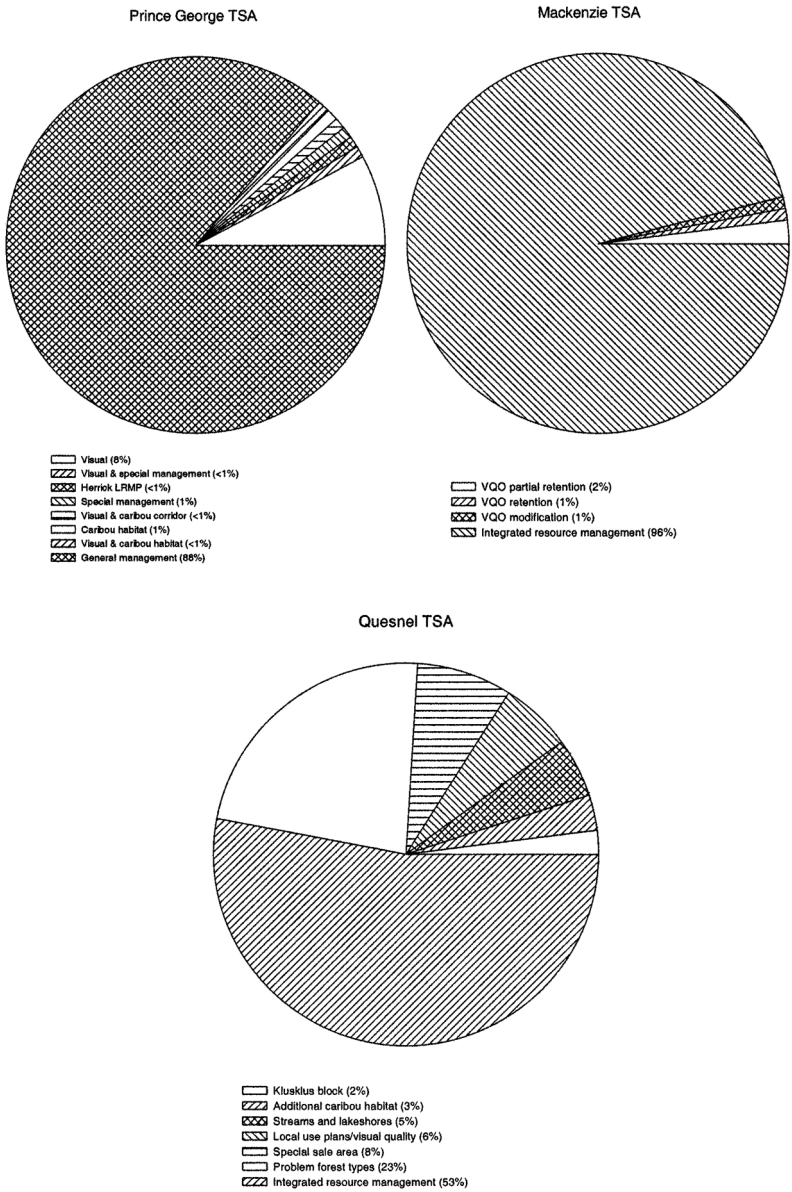

Figure 8 Management Zones of the timber harvesting landbases of the Prince George, Mackenzie, and Quesnel Timber Supply Areas. Adapted from the Prince George, Mackenzie and Quesnel Timber Supply Analysis reports, 2001.

The Caribou habitat zones identified in the Prince George and Quesnel TSAs, and the Wildlife zones in the Mackenzie TSAs, encompass areas considered to be medium habitat quality. High caribou habitat areas are often removed from the timber harvesting landbase, and low quality areas are included in the integrated resource management zones. The caribou management zones have specific restrictions associated with them that limit the percent of the area that can be less than a specified age, and also limit the amount of area that is not at the "green-up" stage.

Harvesting and Silvicultural Systems

Silviculture is the theory and practice of controlling establishment, composition, growth, and quality of forest stands to achieve the objectives of management[5]. Silviculture systems are harvesting and reproduction methods that are aimed at encouraging particular species and densities of regeneration following harvest. These include the following:

1. Clearcut involves removal of entire stand in one cutting followed by natural or artificial regeneration (planting seedlings).
2. Seed tree cuts leave a specific number of trees per hectare in order to provide a seed source for regeneration.
3. Shelterwood cuts remove the old stand in a series of cuttings over a short period of time, with the first cut leaving trees to provide a seed source and protective environment for reproduction of another crop.
4. Partial cutting involves selective removal of stems while leaving other stems behind and encouraging growth of understory trees to create a perpetually uneven-aged stand.

In central BC, clearcutting followed by planting is by far the most common silviculture system used today. In the past, cut stands were left to regenerate naturally; a practice that had varying success. It wasn't until the late 1970s that production and planting of nursery stock became a common practice in this area. Prior to harvest, each proposed cut-block is surveyed and data is collected on the soil types and vegetation. From this data, the block is stratified into site series that are a sub-unit of biogeoclimatic subzones. From this classification, and from information pertaining to wildlife habitat, riparian areas, and other biophysical features, a forester determines a "Silviculture Prescription" for the block. This prescription describes how the block is to be harvested, the type of silviculture system to be used, the type of seedling stock (size,

species), and other features that are important to meet the reforestation objectives for that block.

Harvesting of trees in the central interior is often done by feller-buncher machines. These machines are able to cut and place trees into piles (Figure 9). Hand-falling occurs on blocks with large diameter trees, or where the terrain does not allow operation of a feller-buncher. Logs are moved from the stump to landings (areas where logs are piled then loaded onto trucks for transport) by rubber-tired skidders (Figure 10). On the higher elevation sites found in the ESSF zone in particular, cable logging systems are sometimes used where the terrain is steep enough to provide the required lift. Most of these harvest systems are used with a clearcut and plant silvicultural system, although there are some areas being partially cut with cable systems.

Once harvesting is completed on a cut-block, site preparation is carried out if prescribed in the Silviculture Prescription. Generally this occurs the year after harvest and involves either burning (broadcast or spot) or mechanical treatment (windrowing or piling debris, mounding and others). Mechanical site preparation is the most common form of site preparation in the Prince George area. In 1997/98, 20,379 ha were mechanical site-prepared in the Prince George Forest Region, compared to 5,760 ha prepared by burning. Broadcast burning was more common in the 1980s, but concerns regarding nutrient loss and air quality have resulted in significant decrease in burning for silvicultural purposes (Bartlett 1996).

Planting is generally carried out the year following site preparation. In 1985, the Provincial and Federal Governments combined to produce the Forest Renewal Development Agreement (FRDA). One of the programs under FRDA was "backlog reforestation" or site rehabilitation, preparation and planting of areas considered not satisfactorily restocked. This resulted in a two-fold increase in area planted in the Prince George Region between 1987 and 1995 and a tremendous increase in seedling production capacity in the area. In the early 1980s, seedling production was divided equally between bare-root (grown in fields) and container (grown in styrofoam containers in a greenhouse) stock. Container stock was more popular in the interior, with bareroot stock being used more frequently on the coast. Since 1984/85, the trend has been toward container stock because the environment can be controlled, and operations such as lifting seedlings are easier.

Figure 9 Feller-buncher machine. Photo by Dr. Han-Sup Han, UNBC

Figure 10 Rubber-tired skidder. Photo by Dr. Han-Sup Han, UNBC

For the purposes of long-term forecasting of timber supply, an estimate is made for the time it takes to successfully establish a new crop of trees on a harvested area. This is called the regeneration delay and is a function of soil conditions and climate. In the Prince George TSA, the regeneration delay is usually between 2 to 4 years. The Mackenzie TSA is similar with the regeneration delay being 3 years on average. In Quesnel, with drier sites, the regeneration delay tends to be longer and is estimated at 4 to 7 years.

Tree Improvement

Forest tree improvement involves breeding trees for increased growth rate, improved wood properties and resistance to disease and insects. Early tree improvement research in the central interior, focussed on testing the performance of many provenances of interior spruce, lodgepole pine, and Douglas-fir. The results of this work lead to development of seed transfer rules that guide location of seed collection relative to where the seedlings will be planted.

The Prince George Tree Improvement Station (PGTIS), located on the west bank of the Fraser River across from Red Rock, was established in 1973. It consists of lodgepole pine seed orchards and provenance trials. The PGTIS has the largest provenance trial for lodgepole pine in BC.

Breeding programs, aimed at producing healthy, fast-growing trees, involve selection of healthy, well-formed parent trees that exhibit insect and disease resistance. Branch tips are removed from these parent trees and grafted onto seedlings. This produces clones of the parent tree (genetically identical) which are then planted in seed orchards and managed intensively for seed production. Seedlings from these clones can be produced from specific crosses of known parentage then tested in experimental plantations to determine the best combinations.

A lodgepole pine breeding program was initiated at the PGTIS in 1975 when pine became of commercial interest. The station currently has four seed orchards holding 200 grafted parent trees.

Timber harvesting and the landscape

Timber harvesting impacts on the landscape in the central interior can be described in three phases. The first phase began with harvesting of trees along rivers that provided a mode of transportation. During this phase, the only trees harvested were those that were most commercially desirable. This included larger diameter spruce and Douglas-fir. Less commercially suitable species, such as

lodgepole pine and sub-alpine fir, were left behind, as were the smaller diameter trees. The results of this phase, which lasted until the early 1960s, are residual stands that are well-stocked, but have a high proportion of less commercially desirable species. Most of this harvest was concentrated in areas around rivers and the numerous small bush-mills that existed prior to mill amalgamation. The area along the Fraser River, in what is now Canfor's Tree Farm License, and the area surrounding Prince George, have been significantly impacted by these early harvesting operations, in terms of stand age structure and species composition.

The second phase of timber harvesting occurred with industrial expansion, including the establishment of pulp mills. This is the clearcut logging phase which saw expansion of logging operations up into side valleys using networks of roads to transport the logs. Clearcuts were designed to be most efficient for harvesting purposes and as a result, tended to be square in shape, and spaced at regular intervals along roadways. With the advent of more efficient mills that were able to handle small diameter trees, harvest operations expanded into drier ecosystems, where the predominant tree species was lodgepole pine. As a result, regularly-shaped clearcuts are ubiquitous throughout the central interior. Figure 11 shows the "Patchwork Quilt" effect of this phase of logging. One of the more notorious clearcuts created during this time was the "Bowron Clearcut". The Bowron River flows north from Bowron Lake to the Fraser River. In 1975, very strong winds caused extensive blowdown of spruce trees in the upper Bowron valley. Blowdown occurred in large patches, and in single, more or less uniformly distributed, trees. Salvage logging of the windthrown trees was quickly initiated, but much of the area was inaccessible. The Spruce Beetle *(Dendroctonus rufipennis)* prefers windthrown trees for host material. Population build-up of the spruce beetle occurred in the individual windthrown trees (windthrown trees in patches usually provide unsuitable host material due to higher temperatures resulting from the open canopy) in areas that had not been salvaged logged. Spread to surrounding standing timber occurred as preferred host material became scarce. The beetle outbreak was first observed in 1979 and proved, in subsequent ground inspections, to be very serious. The beetles are normally controlled by harvesting and processing infested trees before the new beetle brood develops into adults then flies to new hosts (called sanitation harvest). Many licensees were relocated to the Bowron Valley to assist with this massive sanitation harvest effort. Between 1981 and 1987, 15 million m3 of infested timber was removed. The spruce beetle outbreak area

covered 175,000 hectares. Of this, 48,000 hectares were harvested and 3,300 hectares were burned by wild fire. Since then, the harvested area has been reforested, primarily with interior hybrid spruce. The area encompassed by the Bowron plantations is extensive, and easily seen in satellite images (Figure 11).

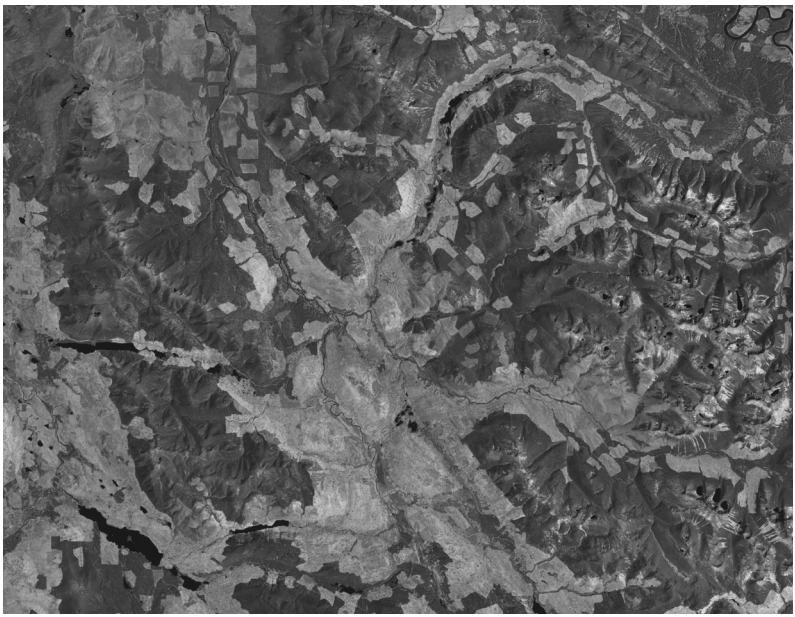

Figure 11 Satellite image of the area around Prince George, to the Bowron Valley

In the mid to late 1980s, as the available timber in the valley bottoms became scarce, harvest operations were moved up in elevation. This move corresponded with utilization of sub-alpine fir, a less commercially desirable species. Most of these high-elevation forests occur in the eastern portion of the central interior, in the foothills of the Rocky Mountains, and in the northern portion, in the Omineca mountain ranges. The movement of harvesting operations into high-elevation forests sparked significant concerns regarding caribou habitat. These and other environmental concerns, were the driving forces behind the very recent shift into the third phase of timber harvesting in this area.

The third phase of timber harvesting and its effects on the landscape, was initiated prior to the 1995 Forest Practices Code, but did not take a firm foothold until the code was implemented. It

involves harvest operations that more closely reflect natural disturbance patterns, and that attempt to account for other values that the forest provides. Regularly-shaped and spaced clearcuts have been replaced with cuts that better reflect natural fire boundaries, that are irregularly shaped with unharvested remnant patches and riparian zones. The effect of this phase on the landscape is not yet visible, except as forecasted maps in planning documents, but should be significantly different from that obvious in Figure 11.

Mountain pine beetle and its impacts on forest landscape of the central interior

Mountain pine beetle is native to forests of BC. It is a stout beetle up to 6 mm long. Adults bore into mature lodgepole pine trees and create vertical egg galleries in the tree's inner bark. Larvae overwinter in the tree and resume feeding in spring, until pupation in June. Adult beetles emerge from mid-July to early September and fly to new hosts. Attacked trees die when the larval activity, and infection by a blue-stain fungus associated with the beetle, spread around the tree and inhibit the flow of nutrients and water between roots and leaves.

Mountain pine beetles usually attack older, large diameter trees, but if the population increases, beetles will attack smaller trees resulting in large areas of tree mortality. The beetle population is naturally controlled by fires and cold temperatures. Areas where lodgepole pine is the dominant species tend to be dry, with relatively frequent fires that kill trees and, before the days of fire suppression, prevented the development of vast areas of large, old pine trees that are the preferred host for mountain pine beetle. Beetle larvae produce an "antifreeze" that protects them from cold temperatures during winter. However, very cold temperatures in late fall, or extremely cold temperatures (-40° C) in winter, kill a high proportion of larvae. Collectively, fire suppression leading to vast areas of preferred host trees, and mild winters since the mid 1990s, have resulted in an enormous outbreak of mountain pine beetle that, in 2001, occupied over 500,000 ha, or twice the area of Vancouver Island.

Efforts to control the beetle have focused on harvesting infested trees before the beetles can spread to surrounding trees. In both the Prince George, and the Quesnel Timber Supply Areas, the AAC has been increased to accommodate this sanitation harvest. Initially, harvest efforts focused on smaller patch cuts around beetle epicenters, but more recently, as the infestation has grown, dif-

ferent strategies are being considered that emphasize natural disturbance patterns while also attempting to reduce beetle numbers.

It is difficult to predict the impacts of the current mountain pine beetle outbreak on environmental and socio-economic features of forested landscapes within the infested area, particularly as this infestation is the largest in BC recorded history. Beetle outbreaks are a natural part of the forest cycle and according to historical records (e.g., McLean 1849) and tree ring evidence, some have been quite extensive. Forest ecosystems in areas susceptible to beetle outbreaks are adapted to this form of natural disturbance. We do not know whether the current outbreak is outside of the natural range of insect-related disturbances due to the effects of fire suppression and changing weather patterns. Therefore the long-term impacts on the ecosystems in the infested area are unknown. However, we do know that the dependency of several communities in the area on the forest industry, and the potential for the outbreak to keep enlarging, indicates that the socio-economic impacts of reduced future timber supply will be both significant and long-lived.

Notes

1. *The Journals and Letters of Sir Alexander Mackenzie,* edited by W. Kaye Lamb. 1970. Cambridge University Press for the Hakluyt Society. p. 259.
2. Forest Resources Commission, *The Future of our Forests,* April 1991.
3. Not signed off as of August 1999.
4. Forest Practices Code of British Columbia, Biodiversity Guidebook, 1995.
5. The Society of American Foresters.

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