PROPERTIES AND UTILIZATION OF LODGEPOLE PINE IN WESTERN CANADA

by

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Sommaire en français

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INTRODUCTION

The range of lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) in Canada (Smithers, 1961) extends from the southern boundary of British Columbia north into the southern Yukon and east through the Rockies to approximately half-way across Alberta. Towards the eastern limit of its range, lodgepole pine is found in association with jack pine (*Pinus banksiana* Lamb), a tree which it resembles in many respects and with which it hybridizes. A twisted, scrubby type of negligible commercial importance known as shore or scrub pine (*Pinus contorta* Dougl.) occurs on the coast of British Columbia but only the inland form of the species (var. *latifolia*) is dealt with in this report.

Lodgepole pine occurs over a wide range of growing conditions and is found in pure stands as well as in mixtures with a number of other species such as Engelmann, white and black spruce, alpine and amabilis fir, trembling aspen, poplars, western larch, ponderosa pine, and Douglas-fir. It is considered a pioneer species (Illingworth and Arlidge, 1960) because it is one of the first species to appear in an area which has been subjected to a major disturbance such as fire or intensive logging. Fire is regarded as one of the primary agents in the establishment of lodgepole pine stands. In parts of its range it has become the predominant species and young stands of pure lodgepole pine cover large areas in British Columbia and Alberta. Its extreme hardiness and ability to reproduce after fire have enabled it to replace stands of other species destroyed by fire and although not a timberline tree it grows at altitudes up to 6,000 feet.

Number of stems and volumes per acre are extremely variable throughout its range. On favourable sites it develops a slender trunk 50 to 100 feet in height and 1 to 2 feet in diameter. Normal yield tables for lodgepole pine in British Columbia indicate a merchantable volume of 3,440 cubic feet per acre for all trees of 6 inches or more in diameter on site index class 40, increasing to 9,800 cubic feet per acre on site index class 90.

The 1961 Alberta Forest Service Inventory (Anon. 1961) reports a volume of approximately 2 billion cubic feet of lodgepole pine 11 inches or more in d.b.h. Recent annual cuts of this species average 27 million cubic feet or 1.35 per cent of the 11-inch or more d.b.h. inventory figures. This inadequate utilization is not peculiar to lodgepole as only about 1 per cent of the inventoried 11-inch or more d.b.h. coniferous volumes and 16 per cent of the gross allowable annual cut for conifers in Alberta was actually utilized in 1963-64. Much of the forested land in Alberta, particularly in the north, is as yet untouched but current developments in northern areas such as the Peace River District should increase the utilization of all species.

It is estimated that approximately 20 per cent of the total commercial tree

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FIGURE 1. Open stand of lodgepole pine in interior British Columbia at about 4,000′ elevation.

FIGURE 2. More densely stocked stand of lodgepole in same vicinity as stand in Figure 1.

volume in the interior of British Columbia consists of lodgepole pine (Anon. 1957) yet the annual cut of this species has never amounted to more than 12 per cent of the total annual cut of all species in the interior. However, in the period from 1954 to 1964 the volume of lodgepole pine cut increased from 19 to 77 million cubic feet or by 30● per cent compared to an increase of 150 per cent for all species in the interior. The availability of the species and the recent improvements in handling techniques point to further increases in the annual cut and greater utilization of the lodgepole pine resource.

CHARACTERISTICS

Lodgepole pine is normally a two-needle pine although occasionally individual trees may be found bearing leaves in bundles of three. The needles are usually about 2 inches in length although they may vary from 1 to 3 inches. The mature cone is yellow-brown, egg-shaped, 1 to 2 inches long with thickened scales usually armed with slender spines. Jack pine is also a two-needle pine with many similarities to lodgepole but differs in that its mature cones are usually curved and pointing towards the tips of the branches and normally have unarmed scal s.

The wood of the lodgepole pine varies from light yellow to white, is soft, straight-grained, of uniform texture and contains numerous resin ducts. Growth rings are distinct and the transition from spring-wood to summer-wood is more or less abrupt. Medullary rays are not visible to the naked eye and dimpling is visible on the split tangential surface.

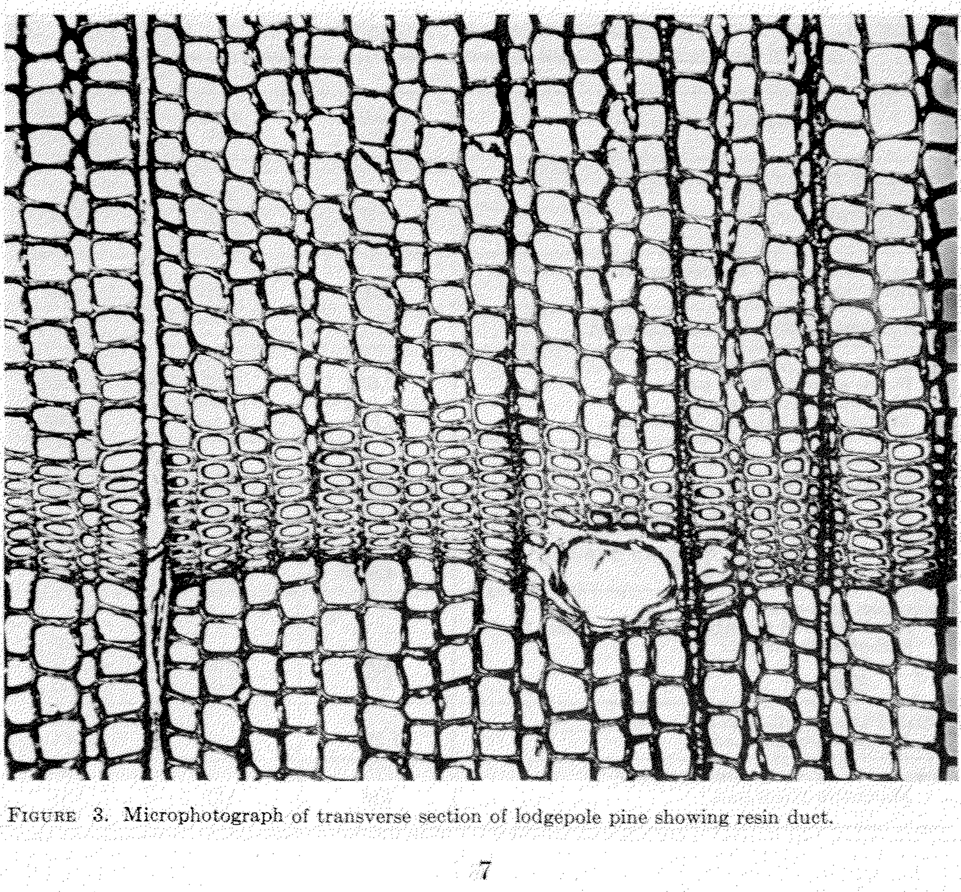

FIGURE 3. Microphotograph of transverse section of lodgepole pine showing resin duct.

The small trees of lodgepole pine do not produce much clear lumber but do yield a good grade of stock with small tight-knots. The wood machines well, takes paints and varnishes satisfactorily and, untreated, is of moderate durability.

MECHANICAL AND PHYSICAL PROPERTIES

Table 1 (Kennedy, 1965) shows the average mechanical properties of lodgepole pine at 12 per cent moisture content. Similar properties for white spruce and jack pine are also shown for the purposes of comparison.

In CSA 086-1959 "Code of Recommended Practice for Engineering Design in Timber", lodgepole pine is grouped with spruce as a Group III wood, and in the National Housing Standards for 1961 is allotted the same maximum spans as the western spruces.

Table 1 shows that lodgepole pine is superior to white spruce in every strength property except impact bending and compares favourably with jack pine.

It is the practice in some areas of British Columbia and Alberta to sell lodgepole pine lumber with that of spruce and to make no distinction in value between the species. This is largely a matter of convenience and although pine on the average is stronger it is unlikely there will be any general premium for this species over spruce as long as there is no distinction between the two species in accepted span tables.

TABLE 1. MECHANICAL PROPERTIES OF LODGEPOLE PINE, JACK PINE AND WHITE SPRUCE AT 12 PER CENT MOISTURE CONTENT (AIR-DRY)

Mechanical Property	Lodgepole Pine	Jack Pine	White Spruce
SHRINKAGE (PER CENT) GREEN TO OVEN DRY			
Radial	4.7	4.0	3.2
Tangential	6.8	5.9	6.9
Volumetric	11.4	9.6	11.3
SPECIFIC GRAVITY — VOLUME AIR-DRY WEIGHT OVEN-DRY	0.41	0.44	0.37
WEIGHT PER CUBIC FOOT (LB.) (AIR-DRY)	29	31	26
STATIC BENDING (AIR-DRY)			
Stress at prop. limit, p.s.i.	7,050	7,080	5,320
Modulus of rupture, p.s.i.	11,020	11,300	9,090
Modulus of elasticity, 1,000 p.s.i.	1,580	1,480	1,440
IMPACT BENDING (AIR-DRY)			
Stress at prop. limit, p.s.i.	10,780	10,660	10,920
Modulus of elasticity, 1,000 p.s.i.	1,830	1,970	2,000
Drop of 50-lb. hammer at completed f ilure, in.	22	25	24
COMPRESSION PARALLEL TO GRAIN (AIR-DRY) Stress at prop. limit, p.s.i.	4,450	3,450	3,710
HARDNESS (AIR-DRY) Load required to imbed 0.444-in. sphere to half of diameter, lb.:			
Side	492	575	423
End	673	719	555
SHEAR PARALLEL TO GRAIN (AIR-DRY) Maximum stress p.s.i.	1,238	1,194	985
TENSION PERP. TO GRAIN (AIR-DRY) Maximum stress p.s.i.	548	530	475

However there is an increasing demand for lodgepole pine lumber for house construction and some operators in the interior of British Columbia have found it desirable to augment their facilities specifically to increase their production of lodgepole pine studs.

Effect of Red Heart Stain on Strength and Durability

A common characteristic of mature and over-mature lodgepole pine is red heart stain. This discoloration may detract from the appearance of the wood but is not considered a cause for rejection of structural lumber.

Western Wood Products Association (W.W.P.A.) grading rules (1961) used for structural lodgepole pine consist of 5 grades—select merchantable, construction, standard, utility and economy. Dependent on other characteristics, as much as 100 per cent red stain is allowed in a piece in the construction grade and narrow streaks of firm white specks are permitted in the standard grade.

Investigations in Alberta (Roff and Whittaker, 1963; (Jeffrey and Loman, 1963) and British Columbia (Roff and Whittaker, 1963) showed that three fungi—*Fomes pini*, *Stereum pini* and *Stereum sanguinolentum*—were responsible for over 80 per cent of red heart stain encountered in lodgepole pine.

Roff and Whittaker (1963) investigating the effect of red heart stain, on the strength properties and durability of affected wood found no reduction in either specific gravity or compressive strength, nor did the stain reduce the durability of the wood. The study also showed that a reduction in static bending and in toughness of not more than 15 per cent could be expected in wood containing up to 80 per cent firm red stain.

Table 2 shows the relative strength and specific gravity of red-stained and unstained lodgepole pine specimens from British Columbia and Alberta.

TABLE 2. RELATIVE STRENGTH AND SPECIFIC GRAVITY OF RED-STAINED AND UNSTAINED LODGEPOLE PINE FROM BRITISH COLUMBIA AND ALBERTA*

Appearance of Wood	Number of Specimens	Specific Gravity	Static Bending	Compression Parallel	Compression Perpendicular	Shearing	Toughness
		Weight At Test (Unseasoned)	Modulus of Rupture (p.s.i.)	Max. Crushing Stress (p.s.i.)	Stress at P.L. (p.s.i.)	(p.s.i.)	(in/lb)
Unstained	159	.501	6,173	2,485	230	669	180.0
Stained	1,033	.509	5,353	2,535	242	688	147.5

*Tested as unseasoned 1" x 1" clear specimens.

Durability tests (Roff and Whittaker, 1963) showed that toughness was reduced by 37 per cent in unstained material and by 30 per cent in stained material after five months exposure in the soil.

Test results indicate that regardless of cause, red stain in lodgepole pine does not advance in service in the ground even though the causal fungi may remain viable for up to four years in air-dry wood. However in laboratory tests on fresh-cut, stained wood kept moist under sterile conditions, the decay organisms continued to develop into the typical stringy or white-pitted rot.

Therefore, when material cut from stained logs is to be stored, provision for air-drying is required to prevent further development of the decay. Where stained lodgepole pine is used in the ground as poles or ties, soil-borne fungi apparently inhibit further growth of the staining organisms so that red heart is of no consequence in such instances.

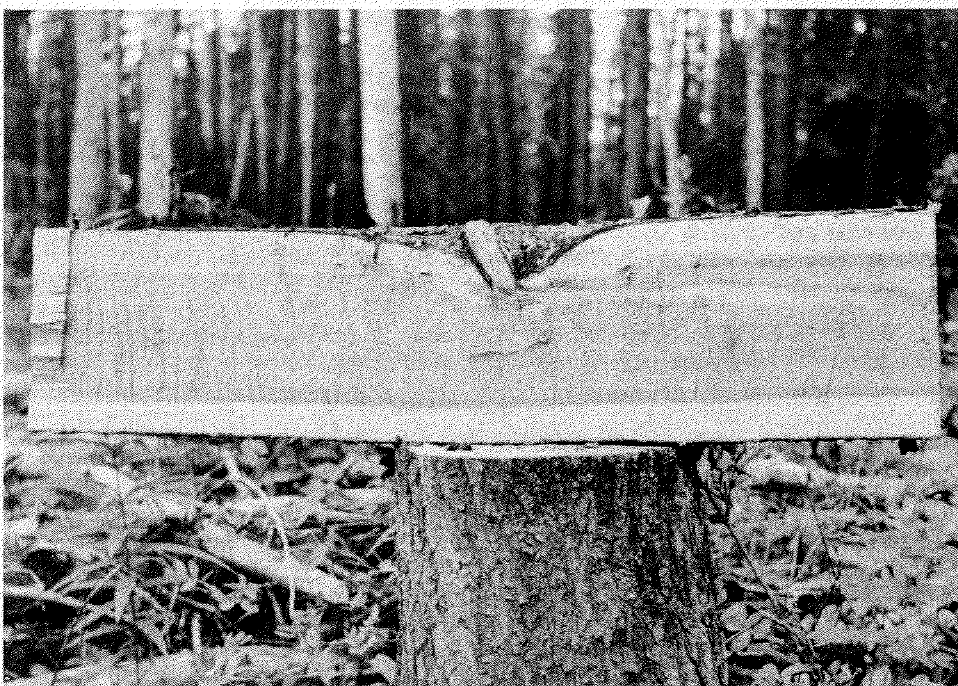

FIGURE 4. Red heart stain in lodgepole pine.

Chemical Composition and Properties

A chemical analysis of mature lodgepole pine trees from Montana by the U.S. Forest Products Laboratory (McGovern, 1951) showed the following:

Holo-cellulose	71.6%
Alpha-cellulose	47.3%
Lignin	25.9%
Total Pentosans	10.9%

The solubility of the green wood in the solvents below was:

Alcohol benzene	2.8%
Ether	1.3%
1% Sodium hydroxide	11.6%

Studies in the Western United States (Schorger and Betts, 1915) showed that the yield of oleoresins from lodgepole pine for the production of turpentine and other naval stores was too small to be economical. However, the pulp mill at Hinton, Alberta, which uses lodgepole in its mix, now recovers what is known as tall oil from its kraft pulping process and ships it to Japan. Tall oil, a fatty resinous residue of chemical pulp, is used in the manufacture of soaps and greases.

The Forest Products Laboratory at Madison, Wisconsin (Rowe and Scroggins, 1964; Smith, 1964) and the Pacific Southwest Forest and Range Experiment Station (Mirov, 1961), have recently conducted research in the chemistry of lodgepole pine bark and wood.

A current investigation[2] at the Vancouver Forest Products Laboratory has indicated that because of differences in their wood oils, it would be possible to differentiate between the lumber of lodgepole pine, jack pine and their hybrid.

The gross calorific value of lodgepole pine is reported[3] to be 20,100,000 Btu per cord at an average 20 per cent moisture content—approximately 8,800 Btu per oven-dry pound of wood.

USES

Typical uses for lodgepole pine (Anon. 1951) include lumber, poles and piling, railroad ties, construction timber and sulphate pulp. Other uses include plywood, corral rails, fence-posts, fuel wood, rustic furniture, orchard props and Christmas trees. In the past, the major uses of lodgepole have been for railroad ties and mine timbers but in recent years its use as a lumber species has increased to the extent that now about 70 per cent of its utilization in British Columbia and Alberta is as lumber.

Lumber

Long experience with lodgepole pine in parts of the United States has shown that it can serve all the uses of lumber (Zischke, 1956). It produces excellent drop, bevel and log cabin siding, panelling and moulding patterns. Its good insulation properties, resistance to splitting and stiffness make it an excellent wood for sheathing and sub-flooring material. The small, sound knots make it an excellent wood for knotty pine panelling and woodwork. It is used widely and successfully as studding, stringers and for concrete forms.

Most of the lumber produced from lodgepole pine in British Columbia and Alberta is dimension and is mixed and shipped with white spruce. Specialty items such as knotty panelling, roof decking, precision trimmed studs, and railway car decking constitute a minor but growing percentage of present lumber production in these areas.

Poles and Round Timbers

Between 30 and 40 million lineal feet of lodgepole pine poles, piling and round timbers were produced in Alberta in the year of 1963-64 (Anon. 1964). In the interior of British Columbia, approximately 10,000 lodgepole pine poles per annum are put into service for power and telephone lines.

In many respects lodgepole pine is excellent pole material (Grantham, 1945). Seasoned lodgepole pine poles have good strength properties; the trees have very slight taper; the wood is soft enough to facilitate climbing and the sapwood is easily treated.

It is recommended that lodgepole pine poles be given full-length preservative treatment, although many poles are only butt-treated. Creosote solutions are recommended in wetter areas but pentachlorophenate and other soluble salts are

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[2] Swan, E.P. 1964. Chemical methods of differentiating between Western conifers. Forest Products Research Laboratory, Vancouver, B.C. Project V-111-2, Prog. Rep. No. 1.

[3] Hale, J.D. 1952. Heating value of wood fuels. Forest Products Laboratories of Canada. Mimeo 0-89 (Unpublished Report).

satisfactory in the drier areas where leaching is not a factor. In a recent study in Alberta by the Vancouver Forest Products Laboratory, it was found that lodgepole pine poles treated full-length with osmose salts (fluor-chrome-arsenic) were more decay resistant above the ground than butt-treated western red cedar. Butt-treated pine, however, were more susceptible to decay above ground-level than butt-treated cedar.

Results of a study of accelerated drying (Lowery and Rasmussen, 1963) indicate that lodgepole pine poles can be dried in 2 to 3 days at relatively high temperatures (180°F to 200°F) and can be satisfactorily treated with preservatives.

Round timbers of lodgepole pine are used in the mining industry and for cons ruction purposes, including farm and rustic structures.

Preservative treatment is recommended for timbers in contact with the ground. Such treatment prolongs the service life of such materials.

Specifications for the physical properties of jack, lodgepole and red pine poles and reinforcing stubs are outlined in the Canadian Standards Association Specification 015.3—1960.

FIGURE 5. Lodgepole pine poles and stubs air-drying before preservative treatment.

Ties

Lodgepole pine has long been used for railroad cross-ties. Its comparatively small size with minimum taper made it an ideal species for the production of hewn ties along railroad locations in the past.

Recent annual production of lodgepole pine ties in Alberta and British Columbia has varied between 600,000 and 1 million pieces. Approximately 300,000 of these ties are used annually in the two provinces for new lines and replacements.

Although not considered one of the durable woods, a service life of at least 20 years is expected from treated ti s of lodgepole pine and failure is more often due to wear rather than to rot.

Tests by the Ottawa Forest Products Laboratory on jack pine—the eastern Canadian counterpart of lodgepole pine (Atwell, 1948)—showed that the service life of untreated ties containing firm red stain is equal to that of sound ties, and that when creosoted, such ties give excellent service. It was also found that the fungi associated with red stain gradually die out under service conditions.

Pulpwood

Lodgepole pine is a highly acceptable species for sulphate pulping. Tests by the U.S. Forest Products Laboratory (McGovern, 1951) showed that in comparison with jack pine, it was equal in bursting strength, higher in tensile strength and folding endurance, and slightly lower in tearing strength. The yield of screened pulp was 46.6 per cent.

It was also found a satisfactory wood for sulphite pulp and, when properly cooked, it bleached easily. The yield was approximately that of sulphate pulp.

Ground wood pulps made from lodgepole pine were of excellent colour and satisfactory strength.

The manufacture of pulp in Alberta commenced in 1956 at Hinton. Since that time the utilization of lodgepole pine at this mill, which at present is the only pulp mill in Alberta, has increased from 30 to 60 per cent of the mix. The consumption of pulpwood in Alberta for a 12-month period of 1962-63 was approximately 180,000 cords of pine and 120,000 cords of spruce.

At present only a very small percentage of pulp chips produced in the interior of British Columbia is lodgepole pine. However, several new pulp mills are proposed for the interior and with their construction the consumption of all interior species suitable for pulp will increase.

Pulpwood should prove a satisfactory outlet for stands of small, stagnated lodgepole pine which occur fairly frequently in areas of Alberta and the interior of British Columbia.

Veneer and Plywood

A limited quantity of lodgepole pine is utilized for veneers and plywood in British Columbia and Alberta. Although little clear veneer is produced there appear to be few difficulties in veneer manufacture when suitable logs are used.

Resin canals and high pitch content are troublesome features encountered in the gluing of pine, but with the proper procedure these difficulties can be overcome and acceptable glue bonds formed for plywoods.

A United States study (Carstensen, 1961) reported no difficulty in gluing veneers of ponderosa, sugar and western white pine with a variety of adhesives including cold-press protein, hot-press protein, urea, melamine urea and interior and exterior phenolic formulations.

Miscellaneous

The versatility of lodgepole pine is evident from the variety of uses, in addition to those previously elaborated upon, to which it is put on the local scene.

The species is used for corral rails, shingles, lath, orchard props, hop-poles, fence-posts, fuelwood and rustic furniture in both British Columbia and Alberta and a study by the Madison Forest Products Laboratory of the United States Forest Service (Schwartz, 1958) indicated its suitability for the manufacture of hardboard.

FIRE- OR INSECT-KILLED LODGEPOLE PINE

In the interior of British Columbia and on the eastern slope of the Rockies in Alberta, there are large areas of standing fire-killed lodgepole pine. Many of these areas have fallen prey to insects and rot, but others, possibly through dry climatic conditions, have survived for many years. The results of tests of fire-killed lodgepole pine timbers from the Alberta foothills were reported by Smith (1955). Six shipments of logs were tested in the following conditions: green, air-seasoned, fire-killed 4 yea s, fire-killed 10 years, fire-killed 17 years, and fire-killed 45 years. The 10 year fire-killed wood showed fairly extensive advanced decay as a result of which the strength values were lower than those of the green or air-seasoned timbers. However, the other groups, including the 45-year group, showed equal or even higher values. The general conclusions from these tests were as follows:

1. The strength of fire-killed timbers varies in relation to the extent of decay present. It is evident, however, that minor amounts of decay do not seriously affect the strength.
2. Fire killing does not adversely affect the strength if the wood substance is not visibly damaged at the time of the fire.
3. The fact that fire-killed timber has aged and seasoned *in situ* does not in itself affect the strength properties.
4. The stiffness of lodgepole pine timbers decreases slightly with age but it is not further influenced by fire-killing.
5. It is possible to select fire-killed timbers with unimpaired strength properties with a reasonable degree of accuracy using no other means than visual inspection.

Tests by the U.S. Forest Products Laboratory on pulping qualities of insect-killed lodgepole pine from Montana and Idaho (McGovern, 1951) indicated that except for somewhat lower holo-cellulose and alpha-cellulose contents, the dead wood did not differ appreciably in chemical composition from the green wood, although some of it contained considerable decay.

In sulphate pulping tests, green and insect-killed woods showed similar pulping characteristics and gave nearly the same pulp yields and pulp strengths. Dead wood with 28 per cent decay gave only 5 per cent less yield than green sound wood. In sulphite pulping tests, both types (green and dead) gave satisfactory results with a tendency for the dead wood to pulp more rapidly. Groundwood pulping was also satisfactory for both types, although the pulps from green wood were slightly brighter, stronger, longer in fibre, and had a wider freeness range than those produced from dead wood.

It would appear from the above that, provided decay is not too advanced, fire- and insect-killed lodgepole pine can be utilized for most of the purposes for which live trees are used, since strength values and pulping characteristics are not too adversely affected.

MANUFACTURING PROCESSES

Logging

In British Columbia at the present time the two methods most commonly used to log lodgepole pine are:— (a) to skid tree lengths from the stump to a portable mill at the logging site, or (b) to skid tree lengths to a central landing in the woods where they are bucked into desired log lengths and trucked to permanent mills.

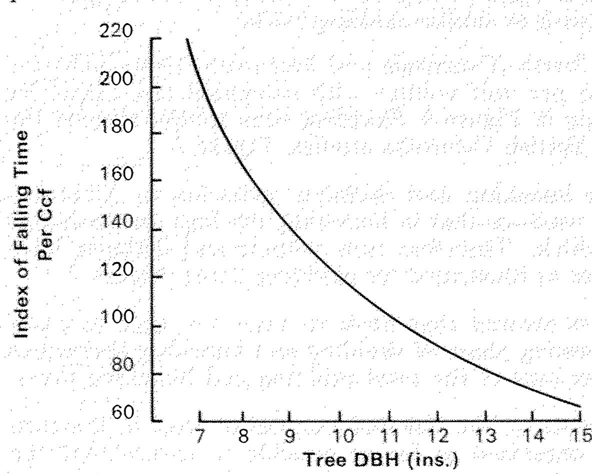
Figure 6 shows the effect of tree size on falling time at four lodgepole pine operations in the interior of British Columbia (McIntosh and Csizmazia, 1965). Although the actual falling times at these operations varied considerably because of stand density, topography, operators' techniques, etc.—percentage differences in falling times per hundred cubic feet between the d.b.h. classes were similar for all four operations.

Falling times recorded included the following phases which contributed the indicated percentages to the average time per tree:

Travel and plan	13%
Swamp	4%
Fall	23%
Limb and top	32%
Saw maintenance and rest periods	28%

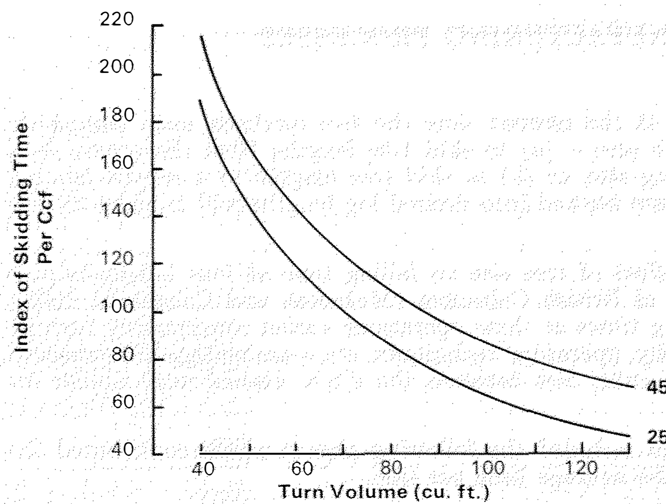
Falling times per tree did not vary appreciably over the range of diameters encountered but times per hundred cubic feet of production increased rapidly with decreasing tree diameters, Figure 6. For example, the average falling time per hundred cubic feet for 8-inch d.b.h. trees was approximately 80 per cent more than that for 11-inch trees and time for 13-inch trees as 20 per cent less than for 11-inch.

Skidding lodgepole pine in the interior of British Columbia is done mainly by crawler tractor at present, although a few operators are using rubber-wheeled tractors. Rubber-wheeled tractors are in widespread use in eastern Canada and in the southern pine regions of the U.S.A. They appear to be particularly suited to small tree harvesting and could probably be effectively utilized in certain lodgepole pine areas of British Columbia and Alberta.



DATA	
DBH	INDEX
7	211
8	175
9	145
10	121
11	105
12	90
13	80
14	72
15	65

FIGURE 6. Effect of tree dbh on falling time per Ccf (Lodgepole Pine — B.C. Interior).



DATA

TURN VOL.	INDEX 250'	INDEX 450'
40	190	235
50	140	168
60	118	142
70	98	122
80	85	108
90	75	95
100	65	85
110	55	78
120	50	72
130	45	68

FIGURE 7. Effect of turn volume and skidding distance on skidding time per Ccf (Lodgepole Pine B.C. Interior).

Figure 7 shows the effect of turn volume and skidding distance on skidding time per hundred cubic feet in the interior of British Columbia. These data were obtained from studies at four operations and although actual times at each operation differed considerably the percentage differences in times for various turn volumes and distances were similar in all four areas. All of the tractors used were of the crawler type and power ranged from 40 to 75 H.P.

In Alberta logging methods are somewhat different from those in the interior of British Columbia. Large areas of muskeg restrict tr harvesting to winter months when the ground is frozen solid enough to support logging machinery. The great majority of sawmills in Alberta are of a portable or semi-permanent nature and operate normally on or near the timber berth being logged.

Tree-length logs are skidded to a central landing in the woods (this operation is known as bunching) by crawler tractors and from there the tree lengths are skidded to the sawmill by arch truck or similar skidding units.

Studies of falling times in Alberta (Csizmazia and McIntosh, 1964) indicated the same trend of increased time per unit volume with decreased tree diameters as illustrated for British Columbia in Figure 6. Skidding time studies showed the same trends as indicated by the British Columbia studies, Figure 7.

The difference between the bunching and skidding operation in Alberta—apart from the different vehicles used—is that in bunching, the logs are decked at the landing by the bunching vehicle. Therefore turn volume and distance have the same effect on bunching times as illustrated for skidding times, Figure 7.

The above-mentioned studies showed that hook-up time, i.e. time to place chokers, was the most time-consuming phase of skidding and bunching operations and required an average of 30 per cent of the total skidding and bunching times.

Turn volume naturally depends on the size and number of trees in the turn and efficient operations will be organized as far as possible to ensure that the skidding machine operates with turn volumes consistent with best operating capacity and minimum hook-up times.

FIGURE 8. Skidding logs to mill site in Alberta.

Milling

Lodgepole pine has been avoided in the past by the larger mills because it is a characteristically small tree. Being small it is more expensive to handle and yields a lower percentage of the clear grades of lumber than larger species.

In Alberta the sawmilling industry has always had to contend with small logs and has done so adequately. In the interior of British Columbia, however, lodgepole pine is the smallest of the merchantable species and economical milling of the small logs has required adjustments in processing techniques. Some companies have overcome the handicap of tree size by incorporating automated processes into existing mills and others have built mills specifically designed to handle small logs.

In sawing small logs cutting for grade is not normally practised. Speed of production with minimum handling appears to be the main consideration in economical operations. Some combinations of breakdown equipment used in lodgepole pine mills are as follows:

Headsaw, cant gang saw and edger
Headsaw, edger and resaw
Headsaw and circular gang saw
Round log gang saw and edger
Scrag mill and edger.

Tables 3 and 4 show the results of lumber recovery studies made at lodgepole pine mills in Alberta and British Columbia (Dobie and McBride, 1964).

The lumber recovery ratio is the amount of lumber recovered in board feet per cubic foot of log and is an indication of sawmill efficiency. Table 3 shows that the two scrag mills in British Columbia had identical ratios of 6.5 for sound logs. These two mills were producing studs from 8-foot logs. One of the other British Columbia mills produced 1-inch boards and had a recovery ratio of 6.0. Mill No. 4 of Table 3 produced studs and had the lowest recovery ratio of 5.0.

In British Columbia stumpage on Crown timber is paid on the basis of log scale. In Alberta, at present, stumpage is paid on (a) log scale, (b) tree scale, or (c) lumber recovered by the mill. The British Columbia method of stumpage

TABLE 3. LUMBER RECOVERY RATIOS (BD. FT. LBR./CU. FT. LOG SCALE) FOR B.C. INTERIOR AND ALBERTA SOUND LODGEPOLE PINE

Mill No.	Mill Type	Location	No. of Logs	Log Length (Feet)	Log Top Diameter (inches) — Lumber Recovery Ratios: 5	6	7	8	9	10	11	12	13	14	Average	Per cent Recovery 1"	2"
1	Circ. Headsaw and Circ. Gang Saw	Alberta	55	16	—	—	5.0	5.0	5.2	5.7	5.9	5.4	5.5	—	5.4	7	93
2	4-Saw Scrag and Edger	B.C.	182	8	6.7	5.8	6.3	6.5	6.4	6.5	6.8	7.2	7.4	—	6.5	8	92
3	2-Saw Scrag and Edger	B.C.	371	8	7.5	6.2	6.5	6.1	6.7	6.3	6.8	6.7	6.6	6.5	6.5	9	91
4	Circ. Headsaw and Edger	B.C.	427	8	3.9	4.9	4.9	5.0	5.4	6.2	5.9	5.5	—	—	5.0	—	100
5	Circ. Headsaw, Cant Gang and Edger	B.C.	297	12–20	5.4	5.5	5.7	5.9	6.1	6.4	6.6	6.9	7.3	7.4	6.[illegible]	100	—

assessment and methods (a) and (b) in Alberta would tend to encourage good lumber recovery practices and operations such as mill No. 4 of Table 3 occur only infrequently. Close utilization is not so important to the operator under method (c) in Alberta but low lumber recovery means high unit volume handling costs.

Table 4 shows the percentage of lumber, sawdust and solid residue recovered in four interior British Columbia mills. The two scrag mills r covered 8 and 9 per cent of their lumber in 1-inch material, whereas mill No. 4 saved no 1-inch, a contributing factor to the percentage of solid residue being equivalent to the percentage of lumber recovered at the mill.

Western Wood Products Association grading rules are used for lodgepole pine and 95 per cent of the volume of dimension lumber recovered from the mills in Table 3 was of a standard and better grade. Grading rules used for boards consist of B and Btr., C and D Clear and 5 Common grades and a grade recovery breakdown for the board mill showed the following percentages:

D Clear and Better	1%
No. 1 Common	11%
No. 2 Common	36%
No. 3 Common	40%
No. 4 Common	10%
No. 5 Common	2%

One of the major disadvantages of small log utilization is the high proportion of narrow boards recovered from them. Figure 9 shows the percentage volume recovered by lumber widths for diameter classes 5 to 12 inches in the abovementioned board mill.

TABLE 4. PERCENTAGE RECOVERY OF LUMBER, SAWDUST AND SOLID RESIDUE FROM 4 B.C. INTERIOR LODGEPOLE PINE MILLS

Mill No.	Mill Type	No. of Logs	Percentage: Lumber	Sawdust	Solid Residue
2	4 — Saw Scrag	535	51	25	24
3	2 — Saw Scrag	1007	51	25	24
4	Circular Headsaw and Edger	191	41	18	41
5	Circular Headsaw, Cant Gang and Edger	149	52	21	27

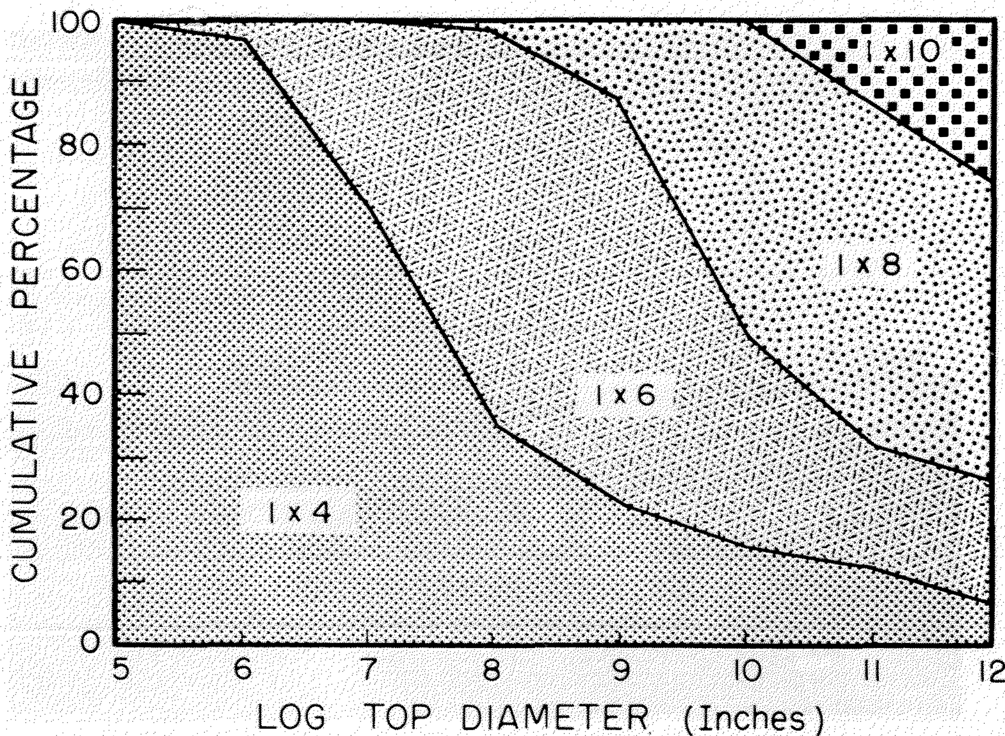


FIGURE 9. Percentage lumber volume by width in each diameter class (Board Mill).

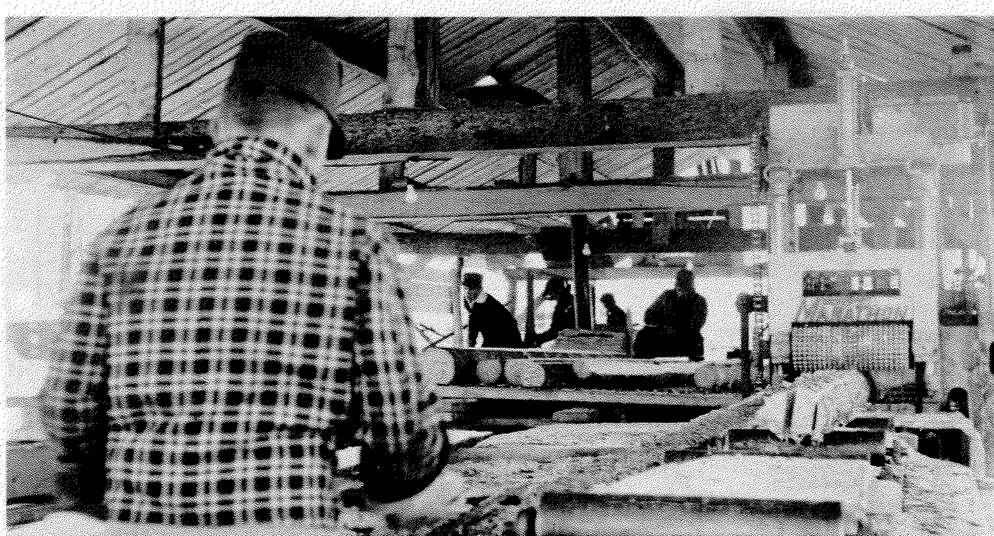


FIGURE 10. Lodgepole pine being gang-sawn at small mill in Alberta.

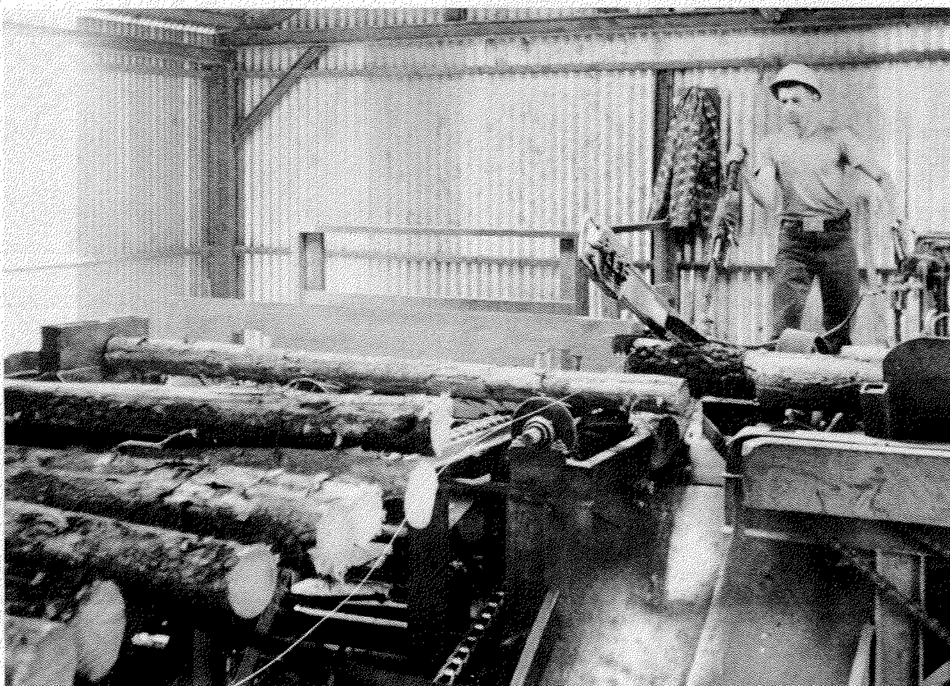


FIGURE 11. Lodgepole pine stud logs being trimmed to length at a mill in British Columbia.

FIGURE 12. Precision-trimmed 2" x 4" lodgepole pine studs.

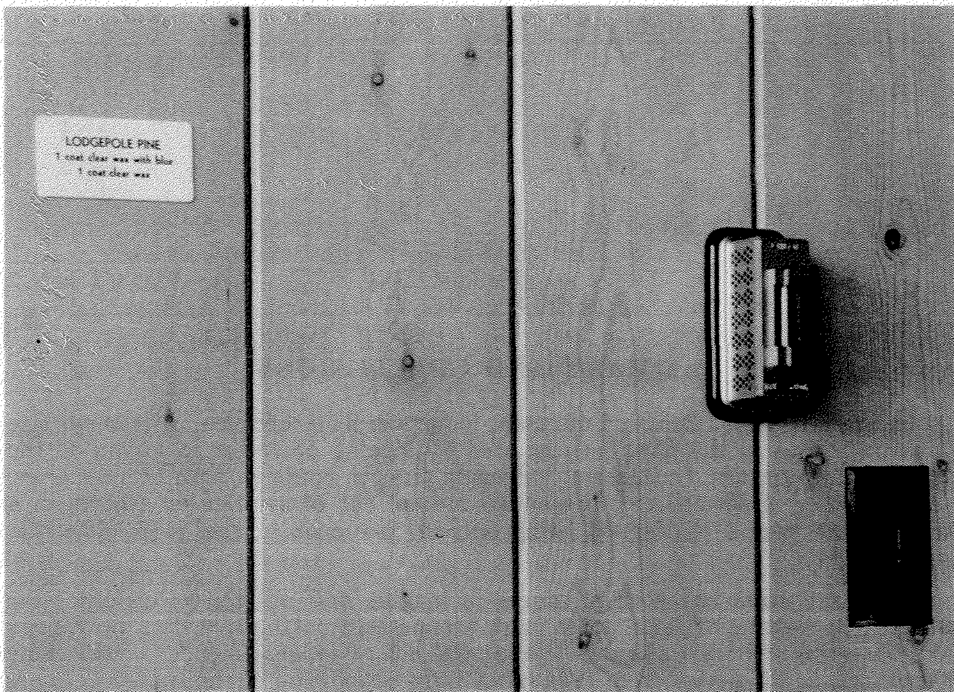


FIGURE 13. Knotty lodgepole pine pane ling.

Wikstrom (1957) suggested that one solution to the narrow board problem would be edge-gluing with resultant higher prices for wider pieces.

Seasoning

Lodgepole pine can be kiln-dried satisfactorily and under properly-controlled conditions develops little degrade.

A schedule for 1- and 2-inch lodgepole pine lumber* (Jenkins and Guernsey, 1954) is as follows:

Time (Hours)	Temperature in Degrees F.		Relative Humidity (per cent)
	Dry-Bulb	Wet-Bulb	
0-24	130	118	69
25-48	140	122	58
49-72	150	126	49
72-dry	150	122	43
Condition at 160°F. and 81 per cent relative humidity, if necessary, at end of run.			

* For 3- and 4-inch roof decking the relative humidity should be 10 per cent higher at all stages.

The use of dry kilns for lumber seasoning in the interior of British Columbia has been very limited, but the number is increasing as operators become more informed of the benefits—such as reduced drying time, reduced inventory, lower final moisture content and reduced shipping weight—to be gained from this type of drying.

In Alberta there are only a few dry kilns and by far the greatest portion of lumber there is air-dried.

SUMMARY AND CONCLUSIONS

In the interior of British Columbia, lodgepole pine, because of its small size at maturity, has in the past been ignored by logging operators in favour of the larger growing species. In Alberta, lodgepole pine, in common with other species, is considerably under-utilized, the actual annual cut of conifers in Alberta in a twelve-month period of 1963-64 being only 16 per cent of the gross allowable annual cut.

In recent years however, advances in logging and milling technology have made the harvesting of small trees more economically attractive than previously and in interior British Columbia the annual cut of lodgepole pine increased by 300 per cent in the period from 1954-64. A large proportion of the timber volumes in Alberta are in the comparatively under-developed northern portion of the Province, but as this area is gradually settled the utilization of all species will increase.

Lodgepole pine is being used and is well suited for a wide variety of products, among them being lumber, pulp, railway ties, utility poles, mining timbers and assorted minor uses such as fence-posts, orchard props, corral rails and Christmas trees. Historically the major uses for lodgepole have been for railway ties and mine timbers, but in recent years in Alberta and B.C. its use as a lumber species has increased to the extent now of about 70 per cent of its utilization.

Most of the lumber produced from lodgepole pine in western Canada is dimension lumber and is mixed and sold with that of spruce and balsam. Its strength properties, however, are similar to jack pine and superior to both spruce and balsam.

It has been found suitable for pulping and the expansion of the pulp industry in the interior of British Columbia with attendant increases in population and services should contribute considerably to continued growth in the utilization of this species for pulp and lumber.

SOMMAIRE ET CONCLUSIONS

Dans l'intérieur de la Colombie-Britannique, le pin de Murray, en raison de sa petite taille, même à maturité, a été négligé par les exploitants forestiers en faveur des essences de plus grande taille. En Alberta également, le pin de Murray ainsi que plusieurs autres conifères sont loin d'être exploités à bon escient, la coupe annuelle de conifèr s (1963-1964) dans la province n'ayant pas dépassé 16 p. 100 de la coupe brute admissible.

Toutefois, au cours des dernières années, les progrès réalisés dans la technique d'abattage et d'usinage ont rendu l'exploitation des essences de petite taille beaucoup plus économique et avantageuse, de sorte que dans l'intérieur de la Colombie-Britannique la coupe annuelle globale de pin de Murray a triplé de 1954 à 1964. Une grande partie des forêts exploitables de l'Alberta se trouvent dans le nord relativement peu peuplé de la province, mais il ne fait pas de doute que toutes les essences de cette région seront exploitées à fond, au fur et à mesure qu'elle se peuplera.

Le pin de Murray convient à la fabrication de toutes sortes de produits forestie s, notamment du bois d'oeuvre, de la pâte à papier, des traverses de chemin de fer, des poteaux électriques et téléphoniques, des bois de mine, ainsi que des piquets de clôture, des tuteurs d'arbres fruitiers, des barres d'enclos à bestiaux et des arbres de Noël. Dans le passé, on se servait surtout de pin de Murray pour en faire des traverses de chemin de fer et des bois de mine, mais depuis plusieurs années, on en fait du bois d'oeuvre en Alberta et en Colombie-Britannique, au point que quelque 70 p. 100 de la coupe de cette essence sert à présent à la fabrication de bois d'oeuvre.

La plupart des sciages de pin de Murray produits dans l'ouest du Canada sont des bois d'échantillon et ils se vendent mêlés aux bois d'oeuvre d'épinette et de sapin baumier. Pourtant, ses qualités de résistance sont supérieures à celles de l'épinette et du sapin baumier, et à cet égard il peut même rivaliser avec le pin gris.

Le pin de Murray convient parfaitement à la fabrication de pâte à papier et sans doute l'expansion de l'industrie de la pâte et du papier dans l'intérieur de la Colombie-Britannique, qui entraînera un accroissement de la population et la multiplication des services, contribuera-t-elle beaucoup à la mise en valeur de cette essence par les industries du papier et du bois d'oeuvre.

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