DEPARTMENT OF THE INTERIOR, CANADA

HON. THOMAS G. MURPHY, Minister H. H. ROWATT, C.M.G., Deputy Minister

E. H. FINLAYSON, Director of Forestry

REPORT

OF THE

DIRECTOR OF FORESTRY

1932-3

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FORESTRY

REPORT OF THE DIRECTOR OF FORESTRY, E. H. FINLAYSON

The total area of forest lands in Canada is estimated at 1,153,000 square miles. Of this area, 26,652 square miles consist of forests growing on occupied agricultural lands, most of which will undoubtedly remain permanently in farmers' woodlots. There are areas now forested which will eventually be cleared for agriculture, but, allowing for this, there remains an area of over one million square miles of land which, if it is to make any contribution to the wealth and progress of the country, must be devoted to timber production.

The extent to which Canada's future is bound up with forestry may be judged by comparing this million square miles of land, unsuited for any purpose but forestry, with the total area of potential agricultural lands amounting to 550,246 square miles, the latter including about 80,000 square miles now under forests.

The total stand of timber of merchantable size in Canada is estimated at 267,733 million cubic feet, of which 165,843 million cubic feet is considered accessible by the existing means of transportation. This accessible timber includes 290,230 million feet board measure of saw material and 920 million cords of smaller material suitable for pulpwood, fuel-wood, fencing, etc. Of the pulpwood species (including the timber large enough for lumber) there is estimated to be accessible

	Million Cords
Spruce	560
Balsam fir	180
Jack and lodgepole pine	134
Hemlock (chiefly in British Columbia)	82
Total	956

Annual use for domestic and industrial purposes in normal times requires approximately 2,970 million cubic feet. Losses due to fire, insects, disease, and storm, which must be added to annual use, bring the total annual depletion in our forests to about 3,900 million cubic feet. In addition, fire destroys, on the average, over one million acres of young growth annually, the average age of which may be set at thirty years. These young-growth areas constitute our main dependence for future timber supplies.

Though there is sufficient forest land on which to produce several times the amount of timber required for domestic or industrial use, most of the young growth has been established following cuttings or fires of comparatively recent date, and will not be merchantable for from 50 to 75 years. Moreover, on large areas, repeated fires have so depleted the stock of the more valuable species that it will take a century or more for nature unaided to rehabilitate the forest. Unless the wastage is reduced there is danger of a period of shortage of accessible merchantable timber before the present young growth reaches maturity.

The situation with regard to timber supplies is serious and demands that remedial measures be applied. Forests take a long time to grow; plans for adequate provision of timber supplies in the future must therefore be laid in advance. The time has now come in Canada for greater attention to our permanent forest requirements.

In normal times the industries dependent on the forest for their raw material contribute to the national wealth over $500,000,000 annually. Approximately half of this goes for salaries and wages, over 244,000 people being engaged

in the conversion of standing timber into usable products. There is practically no industry in Canada which does not derive substantial benefit from the exploitation of the forest.

Normally, more freight cars are required in Canada to transport forest products than are needed to carry grain and grain products. During the years 1926 to 1930 forest-products car loadings averaged 595,528 (17·5 per cent of the total) as compared with 512,995 (15·1 per cent of the total) loaded with grain and grain products. The effect of depression on the forest industries is seen in the decrease in car loadings. During 1931, only 352,123 cars were required to move forest products, and in 1932 only 252,040 cars.

During 1926-30, the average annual value of the exports of forest products (exclusive of printed matter) exceeded imports by $240,872,438, and since about $200,000,000 of this favourable balance occurred in our trade with the United States, it had a most important stabilizing effect on our financial relations with that country.

The extent of the forest resources of Canada and the degree of development of industries based thereon have been briefly outlined in the preceding paragraphs. It is obvious that the problems affecting this basic resource and their adequate solution are a matter of vital public interest. The more important of these problems may be briefly described as follows:—

1. *Stock-taking*

There must be accurate information as to the nature and extent of the forest resource, both merchantable timber and growing stock.

2. *Protection*

The forest resource must be conserved for the use of industry by much greater effort toward the reduction of wastage through forest fires, most of which are preventable. With the enormous increase in tourist travel experienced by Canada in the post-war period forest protection gains additional importance. It is obvious that the forest provides, possibly, the main attraction for our visitors from the United States. It is, therefore, simply a matter of good business to conserve the forest for its scenic effect also, by reduction in forest-fire losses.

3. *Research*

On the silvicultural side information must be gathered as to the rate of growth occurring in the various types and classes of forest under natural conditions, also the most practicable means of securing adequate reproduction and maximum yield. Without this knowledge it is impossible for governments or operators to make intelligent plans for managing their timberlands for continuous production. On the forest-products side (Canada being an exporting country) it is imperative that the forest industries be supplied with the best technical advice as to the most efficient and economical methods of manufacture if world competition is to be met; definite information is also required as to the physical characteristics and most suitable uses of various Canadian species in order that sales may be made to the best advantage.

4. *Management*

The productive forest areas of Canada must be classified, definitely set aside for timber-growing purposes, given proper protection, and managed on a sustained-yield basis. In no other way may Canada obtain the full advantages of the forest heritage with which nature has endowed her, or maintain and develop her forest-using industries on a permanent basis.

5. *Forest Economics*

In practically every forest-producing country, forest economics is becoming an important field of investigation. In Canada, where the forests occupy such

an important place in the domestic economy, the economic problems connected with the administration and exploitation of the forests and the domestic and export trade in forest products demand careful and continuous investigation.

The long-time element, inherent in forestry, requires intelligent forethought. It will not suffice to wait until present supplies are gone before undertaking the building up of a new forest estate. The time has already come when Canada must be laying plans for the future—plans based, not on present supplies or present values, but on a critical analysis of the situation as it will exist half a century hence. What Canada does within the next generation with respect to the application of sound forestry principles will have an enduring effect on her destiny. We are even to-day at the parting of the ways and, if any conclusions are to be drawn from the experience of older countries, Canada must now choose the path which leads to scientific management of her forests. The former policy of waste, neglect, and inattention to the future must be replaced by conservative use, protection, and forethought. It is the duty of the Forest Service of the Department of the Interior to investigate these problems, and the nature of the work carried out is detailed below.

FOREST ECONOMICS

Imperial Economic Conference

The Director of Forestry and the Chief of the Forest Economics Division were appointed Advisors to the Canadian Delegation of the Imperial Economic Conference, and this Division prepared a comprehensive statement on "Canadian Forestry Problems in their Inter-imperial Aspects" for the Economic Committee of the Delegation. A series of statements was prepared also for the Tariff Committee in regard to production of, and trade in, the principal forest products with special reference to the United Kingdom trade, and recommendations as to the tariffs desirable in the interest of reciprocal trade.

The statement prepared for the Economic Committee comprised one hundred and twenty-three pages, including numerous statistical tables and charts. It contained, first, a review of the work of the previous Imperial Conferences as related to forestry, the outstanding feature of which was the Report on Timber, 1928, of the Imperial Economic Committee, which was prepared at the suggestion of the Prime Minister of Canada during the 1926 Conference.

This report contained a statement showing the quantity and value of the average annual production, exports, imports, and home consumption of each of the principal forest products. Expressed in volume of standing timber, the total domestic production amounted to 2,973 million cubic feet, exports 1,277 million, imports 92 million, and home consumption 1,788 million cubic feet.

In the discussion of the relation of forest products to the trade of Canada, it was shown that wood, wood products, and paper (exclusive of books and printed matter) comprised 23·6 per cent of the total exports during 1926-30 and ranked next to agricultural products. The value of the exports of forest products averaged $278,500,721, imports only $37,628,283, leaving a favourable trade balance of $240,872,438. The average quantity and value of each of the main forest products to each of the principal export markets during 1926-30 was given in a table.

The value of the principal classes of forest products exported was as follows:—

Pulp and paper	$183,754,861
Logs, sawn lumber, and other manufactured or partially manufactured wood	92,738,650
Manufactured wood	2,007,210
Total	$278,500,721

The main export markets were as follows:—

United States	$231,812,778
United Kingdom	18,705,129
Japan	8,260,666
Australia	4,861,094
New Zealand	2,279,829
South Africa	1,865,519
China	470,186
All other countries	10,245,520

The figures for the trade in forest products showing the source and quantity and value of each product imported by the following countries were compiled from their own records: United Kingdom, Australia, New Zealand, South Africa, Irish Free State, Newfoundland, and the United States. These studies showed that there were opportunities for a very considerable expansion of the trade for Canadian forest products in the countries of the Empire which the trade agreements consummated at or subsequent to the conference have materially facilitated.

During the conference the Forest Service co-operated with the Canadian Pulp and Paper Association and with the Economic Committee of the Canadian Lumbermen's Association.

Industrial Conditions

The year under review has undoubtedly been the most trying ever experienced by the forest industries in Canada. Following a long period of expansion which culminated in 1929, the steep decline in both the consumption and the price necessitated serious curtailment of operations in the forests, and the closing down of many manufacturing plants. Of the 244,000 people normally engaged in the extraction and manufacture of wood and paper products, it is estimated that over 100,000 were thrown out of employment.

In the pulp and paper industry, production decreased about 20 per cent from the average of the previous five years, and 30 per cent from the peak of 1929. The price of newsprint, which is the main product, was about 30 per cent below the average of the previous five years.

Lumber production decreased to much greater extent, the Canadian Lumbermen's Association estimating a total cut of only about 1,500 million feet board measure in 1932 as compared with an average of 3,693 million during the previous five years, and 4,473 million in 1929.

Since in normal years approximately 43 per cent of the wood cut in Canada is exported in some form, chiefly as lumber, paper, pulp, and pulpwood, the export trade is an important factor in production, and, as about 80 per cent of our exports of forest products have been going to the United States, the industrial conditions in that country have a direct influence on our exports of these products.

The lumber industry in the United States experienced a similar depression, the visible consumption in 1932 being estimated to be only 12,000 million feet board measure, compared with 35,500 million in 1929. In spite of the reduced consumption in this, our best export market, Canadian mills would have been able to secure a fair share of the trade if the United States had not imposed, on June 17, 1932, an excise tax of $3 per thousand feet board measure on all imported lumber and a duty of $1 on sawn lumber and timber of fir, spruce, pine, hemlock, and larch. This practically excluded the cheaper grades of Canadian lumber from this market, and materially reduced the export of the better grades as well.

The effect of these import taxes is apparent in the reduction of our exports of planks and boards to the United States in the fiscal year 1932-3 to 232,845 thousand feet board measure valued at $4,874,777, from an average of 1,175,016 thousand feet board measure valued at $30,555,737 for the previous five fiscal years.

The value of our total exports of wood, wood products, and paper (exclusive of books and printed matter) to the United States fell from an average of $207,561,515 during the five fiscal years 1927-32, to $93,617,640 in the fiscal year 1932-3.

Canada's exports of planks and boards to the United Kingdom increased in volume from an average of 175,483 thousand feet board measure during the previous five years to 197,807 thousand feet in 1932-3, but the value decreased from $5,738,428 to $3,795,809. The United Kingdom normally imports the equivalent of about 5,600 million feet board measure of wood and timber, including 3,800 million feet of sawn lumber, of which ninety per cent is softwood. It is hoped that, with the elimination of unfair competition and the return of higher prices, Canada may be able to regain her share of this trade, which at the beginning of this century exceeded 1,000 million feet board measure annually.

National Inventory of Forest Resources

The compilation of data with respect to forest conditions in Saskatchewan and Alberta was continued, field reconnaissance parties covering some 29,000 square miles in Saskatchewan and 33,000 square miles in Alberta. The areas inspected lay chiefly in the Grove Belt, which is intermediate between the open prairies of the south and the true forest lands of the northern parts of these provinces.

SILVICULTURAL RESEARCH

Research investigations for the year 1932-3 were confined, in Eastern Canada, to the Petawawa Forest Experiment Station, and to the provinces of Nova Scotia and New Brunswick, where a very limited amount of work was done. In the western provinces of Manitoba and Alberta intensive studies of soils and ground vegetation and their relationship to tree growth were carried out, and problems of natural reproduction on cut-over and burned-over areas were the subject of investigation in British Columbia.

Petawawa Forest Experiment Station

The working-plan survey report for the Petawawa Forest Experiment Station having been completed, a general working plan and a series of specific plans for research, silviculture, planting, protection, and administration of the Station for a ten-year period are under way. The objects of the plan are

1. To provide for systematic prosecution of scientific investigations;
2. To provide management for sustained yield; and
3. To provide demonstration of the value of proper silvicultural management.

The Petawawa Station embraces 54,000 acres of forest lands (some of which have been repeatedly burned over and are not reproducing satisfactorily) and 4,400 acres of muskeg, grass, and abandoned farms. Lakes and other water areas amount to 2,600 acres, giving a total of 61,000 acres. The major stands—once a white and red pine type—now, as the result of cutting and fire, are second-growth stands of poplar and birch and white, red, and jack pine (either pure or mixed). The average volume of the material, four inches in diameter at breast-height and over, amounts to twelve cords per acre; but, as the stands are nearly all young, the quantity of material that is at present merchantable is comparatively small. In order of predominance the species are poplar (chiefly aspen and large-toothed aspen), white birch, white pine, jack pine, spruce (white and

black), red pine, and balsam fir. The current annual increment amounts to forty-two cubic feet per acre, distributed mainly over ages varying from twenty-one to one hundred years. It is probable that a cut of 10,000 cords per year will be afforded.

It is proposed that at least two silvicultural methods should be followed in each year's cutting, so that the various methods may be studied comparatively. In addition, thinning and other intermediate cutting methods will be practised on a large scale.

The planting plan provides for the systematic planting of non-reproducing burned areas, as well as abandoned farm lands which cannot be reproduced by natural means. Wherever possible, however, attempt will be made to induce natural reproduction from the margin by exposing the soil during seed-years.

The research plan makes provision for fundamental as well as empirical studies in connection with nursery, planting, and cutting methods. Studies of soil, vegetation, and tree growth, as severally affected by climate, light, temperature, moisture, and root competition, and studies of the seeding and reproduction habits of tree species are some problems to be treated systematically.

A regular system of establishing and maintaining adequate fire protection, including necessary road improvements, must be included.

A second series of permanent sample plots at the Petawawa Station for the study of natural reproduction on abandoned farm land was remeasured and the data analysed. For these plots furrows were ploughed at the margin of fields during the seed-year of 1922. The data show that this method of exposing the mineral soil is decidedly favourable for the establishment of coniferous seedlings. However, ample seed supply and suitable site and moisture conditions are essential. Spruce seems to respond more readily than does white pine. Furrows made for this purpose remain serviceable for at least two years.

Another series of plots to study natural reproduction under forest canopy was analysed. On these plots various methods of removing litter and humus to bare the mineral soil were tried. So far the results are purely negative as far as coniferous reproduction is concerned. Hardwoods apparently take possession of the area to the exclusion of conifers. However, other experiments indicate that the life of these hardwoods is very short and possibly coniferous reproduction will ultimately succeed.

Three permanent sample plots established in a stand of jack pine in 1922—the one heavily thinned, the second lightly thinned, and the third unthinned—were remeasured in 1927 and again in 1932. The heavily thinned plot showed the greatest diameter increase. For the first five years it showed the greatest mortality, but then recovered and showed the least mortality since 1927. For the first period the lightly thinned plot produced the greatest net increment, but the heavily thinned plots led in increment during the second five-year period. The final conclusion, however, is that in stands of young jack pine the best results in total yield are likely to be obtained from thinnings of light to moderate intensity.

Three plots were established on a newly cut-over mixedwood stand to investigate the effect of the selection method of cutting on reproduction and growth.

Work is in progress in comparing the results of aerial timber estimates with ground estimates from permanent sample plots, and for complete subtypes.

Protection improvements at the Petawawa Station for the year consisted in the construction of two miles of road, and the replacing of poles on four miles of telephone line to one of the lookout towers. General maintenance was also continued.

The fourth-year students of the Faculty of Forestry of the University of Toronto, accompanied by the Dean, visited the Station during the course of the field instruction to study research methods in progress there.

General

Woodlot Investigations in Nova Scotia.—Work in Nova Scotia consisted in the remeasurement of ten permanent sample plots previously established on farmers' woodlots to investigate the feasibility and value of silvicultural management of such lots. In addition, four new plots, representing two types, were established. Facts that may be deduced from the analysed data are as follows:

1. In all cases, especially where the original stands were very dense, the effect of the thinning has been to increase the net increment on the remaining stand during the period. The comparative mortality has been greatly decreased on the thinned stand during the period.

2. Barrel stock, firewood, fence-posts, and barn poles can be provided from the thinnings without prejudice to the final crop of timber.

3. Where market conditions are good, thinnings will yield a margin of profit over the cost of making them and help the owner to carry the timber crop while it is growing.

4. By favouring the clean-stemmed, straight trees of the better species, thinnings improve greatly the quality of the final crop and put the owner in a way to get a higher price for his timber.

New Brunswick Rate-of-Growth Survey.—The interim report outlining the results of the rate-of-growth survey of the northern section of the Province of New Brunswick gives stand and stock tables and net annual increment for each of the various age-classes of the several subtypes and a statement of the proportion of the area occupied by each of these age-classes.

It is noticeable that the softwood type amounts to 52 per cent, and the mixedwood type to 36 per cent, the hardwood type occupying only 12 per cent of the area. In the south of the province the hardwood type represents 33 per cent of the stands. The principal age-classes are those between 21 and 100 years. The average stand per acre in each type is made up as follows:—

Type	Material 4 in. to 10 in. Cords	Material 10 in. and over Board Feet
Softwood	10	1,300
Mixed wood	11	900
Hardwood	8	1,500

The average net annual growth amounts to nearly one-third of a cord per acre per year for all species.

Restigouche Drainage Area.—A summary report of conditions found on the Restigouche drainage area was issued to the New Brunswick Forest Service. On this area 62 per cent of the plots examined were of the softwood, 28 per cent of the mixedwood type; 60 per cent of the whole were second-growth stands, less than 100 years old. The soil is largely moist sand or loam. Windfall following cutting has been pretty general, but comparatively little of it has been severe. The annual increment of balsam fir and spruce in the softwood type amounts to about half a cord per acre, in the mixedwood type it is only about a fifth of a cord per acre. Except in second-growth stands under forty years of age, this stocking (saplings included) amounts to over 20 cords per acre. In general, reproduction is ample for future requirements.

Lièvre River (P.Q.) Drainage Area.—A similar report for the Lièvre River drainage area, Quebec, indicates material difference from northern New Brunswick. The softwood type is reduced to 30 per cent, the hardwood increased to 26 per cent. Furthermore, over 40 per cent of the stands are over 100 years of age. The net annual increment ranges from a tenth of a cord in stands under twenty years of age to over half a cord per acre, the largest growth being in the stands from 40 to 60 years old.

University of New Brunswick Forest.—A working-plan survey of the University of New Brunswick Forest, an area of 3,700 acres, was made as a special study of typical New Brunswick conditions. The survey was intended as a basis for a working plan to assist in the training of the students, and also to demonstrate proper methods of forest management. The three major types are about equally represented; the stands are principally from 40 to 100 years of age, much of the material being about ready for cutting. The tract has an average stand of 12½ cords per acre with a net annual increment (all species) of nearly half a cord per acre. Reproduction is already well established. A cut of 1,500 cords might be removed annually under present conditions, if the forest is properly managed, without fear of overcutting. At the same time many research problems may profitably be carried on.

Prairie Provinces.—In Manitoba a field party was engaged in an examination of an area in the Riding Mountain National Park in an endeavour to select an area which would prove suitable for forestry experimental purposes.

In Alberta a field party was engaged in a study of forest sites in lodgepole pine stands where 93 temporary sample plots were examined. Notes were taken on the density of the stand, growth conditions, and the presence and abundance of ground vegetation. The object of the study was to determine the applicability of the Cajander theory of site classification to forest conditions on the east slope of the Rocky mountains.

British Columbia.—A field party made an examination of an area near Loon lake in the lower Fraser valley with the object of determining its suitability for the purpose of forest-experiment work. In addition, remeasurements were made of a number of sample plots established in second-growth and cut-over areas in the Coast district.

In connection with the collection of tree seed for Empire authorities, some research work was undertaken in the development of more accurate germination tests, including methods, appliances, and germination variations attributable to size, weight, source, treatment, and age of seed.

Special timber examinations were made at the request of the Department of National Defence covering certain areas in the Coast district administered by that Department.

Miscellaneous

The Saskatchewan Government has adopted the International Log Rule as its standard. At the request of the Provincial Forest Service, form-class volume tables in the International Log Rule for spruce, balsam fir, and jack pine were prepared.

At the request of the Committee of Engineering Standards, a study of the forms of trees of various species was undertaken, from which tables were prepared showing the taper, the top and bottom diameters, and the length of piling material that can be secured from trees of given species, diameter at breast-height, form-class, and total height.

FOREST PROTECTION IN CANADA IN 1932

During the calendar year 1932 the loss and damage due to forest fires in Canada were the most serious incurred since the disastrous year of 1923. The situation which obtained with respect to forest fires reflected in a measure the economic conditions which prevailed during the same period. The well-known adage "An ounce of prevention is worth a pound of cure" might be aptly applied in accounting for the heavy fire loss. Reduced appropriations and curtailment of staff which were evidenced in nearly every phase of industrial activity were no exception in the various forest-protection services. The result was that many fire outbreaks reached large proportions, eventually involving heavy damage as well as large expenditures before being brought under control.

There was marked variation in weather conditions in 1932 as between Eastern and Western Canada. Weather conditions in British Columbia and the three Prairie Provinces generally were normal, or more favourable than normal. In Eastern Canada, however, the reverse was true. Here the provinces of Ontario and Quebec experienced one of the most severe fire seasons in their history, particularly in the months of May and June. During that period, weather conditions were extreme. Fires of incendiary origin, set for the purpose of obtaining employment, also added to the difficulties in this region. The provinces of New Brunswick and Nova Scotia suffered an unusually bad fire season, with corresponding loss and damage.

British Columbia.—British Columbia experienced the most favourable fire weather conditions in the last ten years, due, in part, to the heavy precipitation received during the previous winter which had the effect of retarding the development of the usually early spring hazard, and also to the timely and well-distributed rainfall during the months of July, August, and September. The province reported 1,266 fires, which represents about half of the fires reported for the two previous seasons. These burned over an area of 394,972 acres, 253,258 acres of which comprised cut-over area; 41,388 acres, merchantable timber; 80,729 acres, young growth; and 19,597 acres, non-forested land. The total damage and loss amounted to $621,603, which includes only $9,986 for fire-fighting costs.

Prairie Provinces.—In Manitoba, apart from a serious spring hazard during the month of May, conditions were not more unfavourable than normally. Forty-six per cent of the 315 fires reported occurred in that month. The total area burned over was 88,762 acres, comprising 21,871 acres of merchantable timber; 34,142 acres, young growth; 27,262 acres, non-forested land; and 5,487 acres, cut-over area. The total loss and damage, including $28,596 for fire-fighting, amounted to $129,569.

The Province of Saskatchewan experienced one of the most favourable seasons in its fire history in 1932, when a total of 121 fires was reported, about 20 per cent of which were of incendiary origin. The month of May presented the only period of real hazard in this province, at which time 101 of the 121 fires occurred. The total area burned over was 81,327 acres, of which 32,767 acres consisted of non-forested area; 9,926 acres, merchantable timber; 32,923 acres, young growth; and 5,711 acres, cut-over area. The total loss and damage amounted to $88,681, of which $7,060 represents fire-fighting costs.

In Alberta, conditions on the whole were about normal. In the southern and central portions of the province, timely spring and autumn precipitation proved a valuable factor in keeping down fires. In the northern district, however, weather conditions were not so favourable, and it was in this region that 90 per cent of all the fires occurred. In all, 378 fires were reported, which burned over a total area of 136,117 acres, of which 33,417 acres were merchantable timber; 27,650 acres, young growth; 6,796 acres, cut-over area; and 68,253 acres, non-forested land. The total monetary loss was $186,482, of which $18,811 represents fire-fighting costs. These figures indicate a tremendous improvement over the previous year for Alberta, when the total damage and loss exceeded one million dollars.

Ontario and Quebec.—The provinces of Ontario and Quebec experienced one of the most severe fire seasons in their history during 1932, particularly during the months of May and June. In that period weather conditions were extreme. Fires of incendiary origin, set for the purpose of obtaining employment, added greatly to the difficulties encountered in this territory.

In Ontario the months of May and June produced 62 per cent of the 2,069 fires reported, which burned over 96 per cent of the total area affected. Some 340 of these fires were attributed to incendiary causes. The total area burned

over was 678,956 acres, comprising 362,796 acres of merchantable timber, 154,897 acres of young growth, 49,634 acres of cut-over timber, and 111,629 acres of non-forested land. The total damage and loss due to forest fires in this province was estimated at $3,590,375, of which $314,947 was actually spent in fighting fires.

In Quebec, weather conditions were similar to those obtaining in Ontario. More than 50 per cent of the 1,466 fires reported were attributed to settlers burning slash, particularly in those areas affected by the "back to the land" movement, where débris was disposed of without the usual permits and necessary supervision. Incendiary fires also proved a serious menace in this province. The total area burned over in Quebec contained 1,027,159 acres, of which 233,631 acres were merchantable timber; 240,968 acres, young growth; 444,794 acres, cut-over area; and 107,764 acres, non-forested land. The total loss and damage was estimated at $3,078,961, of which amount $250,000 was spent in fire-fighting.

Maritime Provinces.—The provinces of New Brunswick and Nova Scotia suffered an unusually bad fire season in 1932, with corresponding loss and damage. In New Brunswick the month of May was particularly hazardous, because of the dry weather which prevailed, with the result that 195 of the total of 269 fires reported occurred in that month. Incendiarism attributed to unemployment accounted for 18 per cent of all the fires which broke out. The total area burned over comprised 37,039 acres, of which 1,529 acres were merchantable timber; 8,702 acres, young growth; 6,654 acres, cut-over lands; and 20,154 acres, non-forested land. The total loss and damage amounted to $166,420, of which $38,275 was spent in suppressing forest fires.

In Nova Scotia conditions were similar to those prevailing in New Brunswick, particularly during the month of May. In all, 328 fires were reported, which burned over 13,235 acres, comprising 2,300 acres of merchantable timber, 3,443 acres of young growth, 246 acres of cut-over land, and 7,246 acres of non-forested land. The total damage and loss amounted to $56,763, of which $12,531 was expended in suppressing fire outbreaks.

The following tables are compiled from reports made to this Service by the various forest authorities. Table I gives in detail the figures for the calendar year 1932, as compared with the average for the 5-year period 1928-32. Table II indicates the number of fires by causes in Canada during the 10-year period 1923-32.

TABLE I.—STATEMENT OF FOREST FIRES IN CANADA DURING THE CALENDAR YEAR 1932, AND COMPARISON WITH 5-YEAR PERIOD 1928-32

Item	Year 1932	Average for years 1928-32
Total number of fires	6,295	6,200
Total area burned over (acres)	2,463,611	2,920,553
Merchantable timber—		
Area burned (acres)	708,085	546,011
Timber burned (M ft. B.M)	549,872	400,173
" " (cords)	2,619,453	1,669,776
Estimated stumpage value	$ 5,056,983	$ 2,804,404
Young growth—		
Area burned (acres)	586,141	644,189
Estimated value	$ 1,209,063	$ 1,279,182
Cut-over land—		
Area burned (acres)	772,625	503,172
Estimated value	$ 615,605	$ 289,423
Non-forested—		
Area burned (acres)	396,757	1,227,180
Other property burned—		
Value	$ 264,769	$ 316,770
Actual cost of fire-fighting	$ 683,650	$ 839,157
Total damage and loss	$ 7,830,070	$ 5,528,936

From the above it will be noted that the total number of fires reported for Canada during the year 1932 was 6,295, which burned over 700,000 acres of merchantable timber. This represents a decrease in number of nearly 10 per cent below 1931, when 6,954 fires occurred; these burned over only 395,000 acres of merchantable timber. The area of merchantable timber burned over in 1932, therefore, represents an increase of approximately 80 per cent. The total loss and damage for 1932 amounted to $7,830,070, which is the highest loss on record for Canada since the disastrous year of 1923 when the total loss exceeded $46,000,000. It also represents an increase over the average loss and damage for the past five years of more than $2,300,000.

TABLE II.—STATEMENT OF FIRES BY CAUSES FOR 10-YEAR PERIOD 1923-1932, IN CANADA

Causes	Year										Total	Per cent	Average annual number of fires by causes, 1923-1932
	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932			
Camp-fires	869	1,014	944	999	669	814	1,332	1,256	1,540	1,302	10,739	18·7	1,074
Smokers	289	480	531	513	369	500	856	762	937	809	6,046	10·5	604
Settlers	1,243	1,018	692	763	532	728	769	966	1,095	1,385	9,191	16·0	919
Railways	964	1,031	711	1,129	574	752	1,011	731	624	354	7,881	13·6	788
Lightning	540	476	978	823	716	485	1,167	1,482	880	651	8,198	14·2	820
Industrial operations	334	269	257	247	129	170	206	160	134	91	1,997	3·5	200
Incendiary	89	229	204	167	95	230	387	521	673	746	3,341	5·8	334
Public works	31	31	28	60	54	35	80	98	97	73	587	1·0	59
Unclassified	310	215	431	260	130	227	240	276	367	243	2,699	4·7	270
Unknown	1,520	861	714	729	337	320	637	553	607	641	6,919	12·0	692
Total	6,189	5,624	5,490	5,690	3,605	4,261	6,685	6,805	6,954	6,295	57,598	100·0	5,760

From Table II it will be noted that some 14·2 per cent of all the fires which occurred in the past ten years are attributed to lightning or natural causes, which leaves the balance of 85·8 per cent due to human carelessness. Of the latter number, campers and settlers are the major causes. During the year 1932, incendiarism occupied fourth place in the list of causes, and a glance at Table II would indicate a steady increase of fires from this source. This situation is to be expected in times of economic stress, since the fires are set usually for the purpose of obtaining employment.

Control of man-caused fires is possible, but the extent to which success may be attained will depend on the funds provided for the organization and equipment of efficient protection services, and most of all upon the thorough co-operation of the forest users. Any relaxation of effort even in normal times may mean that the result of many years of relatively successful protection operation may be wiped out in a single season of serious fire hazard. While Canada's fire losses reached serious proportions in 1932, these might have been even more disastrous had not the western provinces experienced the most favourable weather conditions there in years.

Fire-Hazard Research

Excellent progress was made in the program of forest-fire hazard research studies under way at the Petawawa Forest Experiment Station at Chalk River, Ont. The investigation of the influence of weather factors upon the inflammability of the materials on the forest floor in which fires start or spread was practically completed in three types of forest, namely, mixed red pine and white pine, pure red pine, and mixed jack, red, and white pine forests. Studies were continued in the pure jack pine and the cut-over jack pine subtypes, and extended to the mixed hardwood and the open grassy subtypes.

Final forest-fire hazard tables were prepared from the data collected for the mixed red pine and white pine subtype. These tables convert the daily record of rainfall, relative humidity of the air, and rate of evaporation into terms of fire-hazard expressed as an index of inflammability which may be shown on a chart from day to day. It is thus possible for the forest officer to visualize the trend of fire-hazard each day, to know when conditions are favourable for a fire to start, and how a fire is likely to behave if one does start. With this accurate information the forest officer is able to detail his men and plan the work of his district economically and with greater assurance than when he had to depend on individual judgment in guessing at the degree of fire-hazard. The tables are being used in this way to good advantage by forest authorities in the area for which they were designed.

The study of the effect of soil moisture upon the inflammability of the leaves and litter on the forest floor in the pine types was brought to a conclusion. In these types of forest the natural range of soil moisture is not great enough to have any practical effect upon the inflammability of the dead materials on the forest floor. The inflammability varies directly with the weather and is little affected by the stored moisture in the soil. This study will be extended to the hardwood types.

Fire-hazard research being a new study, much of the apparatus and equipment has to be specially designed. Much valuable work has been done and much is still under way in the improvement of technique and equipment for the conduct of these studies.

The Forest Products Laboratories of Canada

The work of the laboratories is carried out in three centres, namely, Ottawa, Montreal, and Vancouver. The main laboratories are located in Ottawa, the Pulp and Paper Division in Montreal, and a branch laboratory in Vancouver giving attention to problems of the British Columbia timber industry which cannot, on account of distance, be dealt with to advantage in the Ottawa laboratories.

In all these laboratories, service to the industries was well maintained. In spite of very much reduced production of lumber, pulp, and paper, demands for technical assistance from the industries were very keen, in fact showed an increase over the previous year of more than twenty per cent. Of particular note was the fact that so many inquiries referred to technical problems in connection with marketing timbers for both the domestic and the export markets.

Details of the work of the three laboratories follow.

OTTAWA LABORATORIES

Division of Wood Preservation

Fire-retardant treatments of wood.—About fifty chemicals were tested to ascertain their effectiveness in retarding the rapid burning of wood treated with them, and further tests for slow combustion were made on forty selected chemicals. The two types of tests permit a good valuation of the effectiveness of a fire-retardant.

Creosote treatment of green sugar maple, yellow birch, and beech ties.—Treatment of 600 green ties of these species was successfully effected, penetration equivalent to that obtained with seasoned ties being achieved, though at least two years will be required to ascertain satisfactorily the degree of checking after treatment.

Bleeding of timber after impregnation with creosote.—Investigation of the bleeding of telephone poles after being creosoted showed that a short expansion bath removed the excess oil from the outer section of the poles and materially reduced the bleeding after treatment.

Open-tank treatment of red pine lumber.—The advantage of using treated timber in situations where the wood is exposed to moisture is becoming more and more appreciated, but lumber dealers are unable to carry such timber in stock, owing to the great diversity of sizes demanded and the necessity of re-treating the wood if it is sawn and thus a fresh, untreated surface is exposed. Hence a process of treating small quantities of lumber seemed to be a desideratum. With this idea in mind, the Division attempted to develop a process whereby small quantities of timber might be treated as required, a trial being made with red pine lumber. Experiments showed that sapwood may be readily impregnated with creosote oil or with zinc chloride solution by the hot-and-cold-tank process. Heartwood was found difficult to penetrate, even when incised, though the incising did increase the penetration of creosote in timber treated by the hot-and-cold-tank process.

Steam seasoning of red pine and jack pine poles.—In attempting to treat red pine and jack pine in the green condition, as is occasionally found necessary, it has been found that preliminary steaming seems to cause checking of the heartwood throughout the entire length of the poles. The cause of this checking has been under investigation for several years. Work was carried out on 160 red pine poles, treated by steaming and boiling under vacuum, and the results indicated that checking occurs during the preliminary steaming, and is not increased by the vacuum after steaming. The checking is apparently caused by tangential expansion of the wood when heated. The solution of this problem will apparently be a compromise between a treatment sufficiently severe to ensure penetration and one which is not sufficiently severe to cause undue checking.

Open-tank treatment of fence-posts.—The open-tank treatment of fence-posts would be much more widely used were it not for the high cost of creosote purchased in small quantities. The advantage of preserving the post would be secured if the creosote could be applied for a short distance (say, six to nine inches) above and below the ground-line, the point at which decay usually occurs. With a view to overcoming the objection of expense, a method has been devised for reducing the amount of creosote required by partially filling the tank with a strong brine, on which the creosote is floated. The portion of the post near the ground-line is thus brought into contact with the creosote, which it absorbs, while the lower portion absorbs the brine.

Treatment of Canadian cedar for use in the manufacture of lead pencils.—Red juniper, or Eastern red cedar (*Juniperus virginiana*), formerly the only wood used in the making of lead pencils, has, owing to its increasing scarcity, become very expensive, and treated California incense cedar is being used to replace it. It has been thought that Canadian cedar, suitably treated, could be used in place of either of these. The treatment given to the incense cedar includes the use of a water-soluble dye to render that wood similar to the red cedar in colour and also the use of paraffin wax to improve its whittling qualities. A method of treating Eastern white cedar and Western red cedar was developed and sample slats, made from cedar so treated, were forwarded to pencil manufacturers in Canada, England, and Japan. English and Japanese manufacturers reported favourably, but the Canadian manufacturers (all branches of parent U.S. companies) preferred the incense cedar. Study was given during the year to methods to be employed in adapting the laboratory methods to commercial practice.

Division of Timber Mechanics

Tests on small clear specimens.—Tests were made on specimens of white birch, black spruce, white spruce, jack pine, aspen poplar, and balsam fir from Saskatchewan, in the green condition, and matched specimens stored for air-dry seasoning.

Glues and gluing.—The increasing use of veneers and plywood has led to a much greater use of glues in the wood-using industries, and at times the loss to these industries owing to the use of inferior glues has been quite serious. This led to the establishment of a laboratory in connection with the Ottawa laboratories for investigations connected with glues. Here the study of animal, vegetable, and casein glues has been carried on. During the year tests have been conducted on animal glues to determine the inter-relationship of gel, viscosity, concentration of solution, and strength of resulting joint, 1,700 tests having been completed under this project.

Nail-holding power of wood.—Tests of the nail-holding power of various woods were continued; balsam fir, white spruce, jack pine, white pine, Eastern hemlock, basswood, yellow birch, and white elm, all in the air-dry condition, were the woods under investigation.

Shipping containers.—The shipping containers tested included fibreboard containers for the shipment of salt, wooden butter boxes for the marketing of butter in Ireland, wooden boxes for the shipment of chemicals to India, wooden boxes for the export shipment of distilled liquors, plywood containers for the shipment of electrical equipment, and fibreboard and corrugated containers for the shipment of matches.

Testing of structural-size timbers.—A total of 315 air-dried joists—2 inches by 10 inches by 16 feet in size—of red pine, jack pine, white pine, balsam fir, white spruce, and Eastern hemlock was tested. These were the matched specimens of a similar lot of the same number of pieces tested last year in the green condition. The analysis of the results of both the green and the air-dry tests was commenced. The data obtained will assist very materially in determining the safe allowable working stresses for the species tested, as well as in determining the effect of air-seasoning upon timbers of this size.

Strength of sapwood and heartwood of yellow birch and of mineral-stained and of unstained white wood of hard maple.—A start was made in the investigation of the comparative strengths of the sapwood and the heartwood of yellow birch and of the comparative strengths of the mineral-stained and the unstained white wood of hard maple.

Miscellaneous testing.—A great number and variety of tests on timber and timber products were carried out by this division for various associations and firms. The following are typical: Tests for a company manufacturing butcher blocks to determine the hardness of paraffined and unparaffined hard maple; tests for the Royal Canadian Air Force on wood used in the construction of longerons, spars, struts, propellers, etc.; tests for the Department of National Defence on timber for the manufacture of felloes, spokes, gunstocks, wagons, and gun limbers, and tests on glues and glued joints for twelve different furniture and glue-manufacturing companies.

The total number of mechanical tests carried out in the division during the year was 23,587.

Division of Lumber Seasoning

Kiln-drying studies.—The development of brown-stain under kiln treatment was studied, and tentative drying schedules developed; and the study of kiln-drying white pine deals was taken up.

Equilibrium moisture content of Canadian woods.—This study was continued through the monthly weighing of sample boards in commercial yards, and plotting of equilibrium moisture curves.

Air-seasoning studies.—These were carried out under four heads, namely, drying-rate studies, degrade in air-seasoning (losses through checking, cupping, and twisting of lumber in seasoning yards), air-seasoning costs (in co-operation with trade associations), and pile-burn or yard brown-stain.

Other seasoning studies.—A study of the use of yellow birch and hard maple for spokes and felloes of artillery wheels (to replace the imported ash and oak now used) was begun, as was also a study of the seasoning of Canadian maple for shoe-last blocks.

Wood taint in butter boxes.—A co-operative study of wood taint in butter boxes, undertaken jointly with the Department of Agriculture, indicates that moisture content is not a factor in the production of taint, and that the most satisfactory moisture content for lumber used for this purpose is found in the "air-dry" condition, *i.e.*, between eleven and twenty per cent moisture; poplar was found not suitable for this use, but spruce and balsam fir seem equally satisfactory.

Kiln-drying maple and birch for the British market.—Assistance was given industrial plants in adjusting their methods of kiln-drying to United Kingdom requirements in the case of maple and birch flooring, white pine doors, and red pine mouldings.

Kiln-drying of Canadian birch for the British automobile industry.—Co-operation extended by the laboratories in the drying of an experimental shipment of kiln-dried birch to the United Kingdom for the construction of automobile bodies (to replace European beech) resulted in the receipt of further large orders for Canadian birch.

Division of Timber Physics

Porosity of wood.—A simple apparatus has been developed by which liquids can be forced through wood samples under controlled experimental conditions, and this will be used for investigating the penetration of fluids, particularly preservatives, in wood. It may also be of use in general investigative work in woods, as it provides a measure of the areas of open pores on wood surfaces, a character of particular importance in tight-cooperage stock.

Variation in wood.—It is of importance to engineers, architects, and other wood-users to know what variation can normally be expected in the different properties of wood. Variation in density of Engelmann spruce has been studied with the view of discovering easily visible characters which will serve to show difference of density, and hence will aid in the selection of wood for different purposes. The fibre dimensions of Engelmann spruce were also studied, e.g., length and diameter, and the extent to which these characters were correlated with the normal growth characters of the tree.

Identification of pulpwood at the mill.—This investigation was carried on in co-operation with the Canadian Pulp and Paper Association. The accuracy of the inspectors' methods of identifying woods was checked by laboratory methods.

Fuel value of Canadian woods.—During the past two or three years wood has been used in many cases where coal had previously been used; hence interest in the relative fuel values of wood and coal and of different woods has been aroused. A table showing the relative fuel values of Canadian woods was prepared and sent to a number of inquirers on request.

Woods for lead-pencil slats.—Study of the structure of various woods used for making lead pencils has been of service for the selection of Canadian woods suitable for this use.

Woods for storage-battery separators.—The Laboratories have co-operated with the National Research Council in a study of the suitability of yellow cedar (*Chamæcyparis nootkatensis*) for separators in storage batteries. It has been claimed by some users that this wood, in comparison with other woods used for battery separators, shrinks unduly after treatment with caustic soda, with consequent degradation in drying, involving the necessity of keeping the separators wet in storage. The study is still in progress.

Powder-post beetle damage to "calico wood."—A report was prepared on this damage, giving remedies as far as possible. "Calico wood" was found to be light-weight ash.

Division of Timber Pathology

Reference collection of pathological material.—Thirty specimens were added to the collection, which now contains 888 specimens.

Decay of pulpwood in block piles.—Study of fifty sticks furnished by a pulp and paper company showed that the rate of deterioration in those particular samples was not rapid, though it had been claimed that in some cases loss through decay amounted to as much as ten per cent per year. Collections of fruiting bodies of fungi and of rotted wood on which they were growing, made from pulpwood stored at several Canadian pulp and paper mills, showed *Lenzites sepiaria* to be the most common fungus. *Stereum sanguinolentum* was also frequent, and several other fungi were found.

New species of fungus isolated.—Six new species of the genus *Cadophora* were isolated during the year.

Fungi with high tolerance of creosote.—Two fungi—not, however, of the wood-destroying type—isolated from a fungus growth on a creosoted tie were studied.

Elimination of slime from paper mills.—Samples of slime taken from a paper mill before and after the introduction of chloramine were studied. The results obtained indicated that the chloramine had not cleared the system of slime organisms, but from the material submitted it was impossible to determine whether or not the amount of slime was lessened. An investigation is being made of the effect of heat on the slime fungi.

Technical inquiries.—Many requests for information were received from the lumber and the pulp and paper industries, of which the following were typical: Rot-infected pulpwood, pulpwood affected by mould, deterioration of paper-machine felts, moulded mine timbers, mill-yard sanitation, and the relative durability of summer-cut and winter-cut birch.

Division of Wood Chemistry

Plans for the initiation of experimental work on the chemistry of wood were made during the year. The program adopted includes studies on the chemical composition of Canadian woods and on wood finishing. The available literature on these subjects was studied, and apparatus and material for experiment secured.

Division of Markets and Exhibits

Sets of small specimens of Canadian woods, to the number of 145, were sent out in response to requests—mostly from Canada, though a number were sent to the United Kingdom, and others to South Africa, Australia, the United States, Argentina, and China. A number of sets of 8-inch by 15-inch panels were also distributed, and sets of specimens for the collection of European and other foreign wood-samples were received from the United Kingdom, South Africa, Argentina, China, and Finland.

Exhibitions.—Co-operation in the preparation of exhibits of wood produced in Canada was extended to the Information Bureau of the Imperial Economic Conference, the British Industries Fair in London, England, the Central Canada Exhibition at Ottawa, and the Canadian Government Exhibition Commission.

Markets.—Loans for the purpose of study were made to Canadian firms from the collections of foreign-made boxes and crates assembled at the Laboratories, also of foreign-made plywood. Much information was assembled in an investigation of the use of Canadian birch for liquor containers.

Publications

In addition to printed bulletins elsewhere mentioned, mimeographed reports published during the year were the following:—Red Stain in Jack Pine: its development in creosoted and untreated ties under service conditions, by Dr. Clara W. Fritz; Properties and Uses of Canadian Timbers and Competing Timbers in the United Kingdom Market, by T. A. McElhanney; Instructions for the Maintenance of Web-saws, by W. E. Wakefield; Lignasan for the Prevention of Sapwood Stain in White Pine, by Dr. C. W. Fritz; Pencil Wood, by J. F. Harkom, and Softwood Distillation, by J. F. Harkom and M. J. Colleary.

PULP AND PAPER LABORATORY (MONTREAL)

The support accorded to the Laboratory by the Canadian Pulp and Paper Association has been continued. Interest on the part of the Technical Section of that association in the activities of the laboratory has increased, with a consequent demand from this section for further services in the nature of research and pulp and paper testing.

The following are the chief problems which have received attention during the year:—

Methods for Analysis and Testing

Method for the estimation of lignin.—For the orderly running of a pulp mill, it is requisite that the management be able to estimate the quantity of pulp that can be made from a given quantity of wood, expressed in cords, feet board measure, or other unit. In the manufacture of chemical pulp, a large proportion of the wood will be dissolved when the wood is "cooked" in the process of converting it into pulp. This dissolved portion is the lignin, the remainder left to form the paper being cellulose.

A small proportion of the lignin may be left in the wood, and this remaining lignin has much to do with the quality of the pulp, the ease with which it can be worked, and its suitability for various purposes. This problem of estimation of the lignin has been attacked by the Laboratory, and a method has been worked out by which, through the use of sulphuric acid and formaldehyde, results may be obtained which fall within the accuracy demanded for this work.

Screen classification of pulp fibres.—The quality of the pulp, which determines the kind of paper which may be made from it, also demands attention, and this may be given in the form of classification of the fibres by means of screens of various apertures. Work at the laboratories over a period of years has resulted in the production, for the first time, of an instrument by which pulps may be broken up and their component fibres classified according to their maximum dimension. This instrument has embodied a principle not heretofore used, the pulp fibres in suspension in the water being forced at a high velocity across the wire mesh screen, in place of merely being agitated as in the method formerly employed.

In all pulps there are large fibre bundles of improperly disintegrated woody tissue which must be removed before the pulp can be sent on to the paper machine; these are removed by screening. On the other hand, even after this has been done, there is a large quantity of excessively small material. Just as the strength of a chain is determined by its weakest link, so this very small material ("fibre débris") enters into the composition of the paper, and, far from acting as a harmless filler, actually weakens the sheet made from it. The laboratory, at the instance of the Technical Section of the Canadian Pulp and Paper Association, has undertaken the standardization of an instrument which will make an accurate classification of the sizes of the pulp particles. This instrument has been designed and built, and the satisfactory manner in which it has performed under laboratory service gives the promise that final standardization will shortly be accomplished.

Study of the Properties of Cellulose and of Cellulose Fibres

Purely scientific in character has been the study of cellulose and cellulose fibres. The proper and complete understanding of the manner in which water is taken up by cellulose in the process of paper-making is the goal of the investigation, and as an aid to the understanding of this point a study is being made of the way in which cellulose takes up (adsorbs) the vapours from various alcohols. The bonding, or cohesion, of the fibres was further studied through measurements of the swelling of wood on treatment with various solutions. This cohesion of the fibres, as well as the mechanical and chemical disintegration of the wood, is intimately bound up with the properties of the "middle lamella" (the middle layer of the wall of the wood-cell), and the knowledge of its constitution is of great importance to the pulp and paper industry, and perhaps to other industries, such as the wood-bending industry.

Physical Characteristics of Commercial Canadian Ground-woods

A study of the physical characteristics of commercial ground-wood pulp involved the examination in detail of over one hundred pulps (this required the co-operation of ten Canadian mills for several months), and resulted in the accumulation of data which were then circulated among the co-operating mills. The study of this, it is hoped, will be a guide to the production of better pulp.

Study of Pulping Processes

The study of pulping processes was confined to the following subjects: (1) semi-commercial pulping by the alkaline processes; (2) the removal of caustic soda from cooking liquor by chips; (3) the influence of the moisture content of wood on the yield and quality of pulp, and (4) the evaluation by the sulphite process of decay of wood in block piles.

Semi-commercial pulping by the alkaline processes.—Better facilities for making tests of processes on a semi-commercial basis were provided through

the installation of a digester of 50 cubic feet capacity, holding approximately 500 pounds of spruce chips, with special accessory equipment to adapt it to experimental work.

Removal of caustic soda from cooking liquor by chips.—The rate of removal of alkali from the cooking solution was investigated, poplar wood in sodium hydroxide solution being the medium. It was found that the rate of removal is rapid even at low temperatures and increases as the temperature rises. This investigation furnishes a guide to the fortifying of the cooking solution as the digestion proceeds and the temperature rises.

Influence of moisture content of wood on pulp yield and quality.—This study was carried out on spruce, the kraft process being used for the investigation. It was found that the moisture content of the wood exerted no influence on the result of the operation provided account was taken of the dilution of the liquor resulting from the moisture of the wood and provided also that sufficient liquor was present at all times during the cook to completely cover the chips. Where there is not sufficient liquor to cover all the chips at all times the natural diffusion of chemical into the wood is interrupted and therefore chips with the greatest moisture content will contain the most dilute liquor. Where diffusion is allowed to take place and where the liquor circulates freely about the chips an equilibrium is rapidly reached throughout the charge and all the wood has the same treatment.

Evaluation of the decay of the wood in block piles.—Study of this subject was carried on in co-operation with the Division of Wood Pathology, and is referred to elsewhere in this report.

Miscellaneous Services

Industrial research.—A new service was instituted by which facilities were made available to commercial firms and individuals for the testing of processes and for other forms of research; two commercial firms took advantage of these facilities.

Services to other governments of the Empire.—Reports on woods from British Guiana, Trinidad, and Southern Rhodesia were analysed for the colonial governments by the laboratory.

Calibration and standardization of instruments.—Ninety-eight instruments or parts of instruments were calibrated by the laboratory for the Canadian pulp and paper industry.

Analysis and testing.—Considerable use was made of the testing facilities of the laboratory by Canadian mills.

Minor investigations.—These included the evaluation of Engelmann spruce by the sulphite process for the main laboratories, the study of anhydrite as a filler for paper for the Mines Branch, Department of Mines, the preparation of a non-nutritive cellulose feed for animals, and the screen classification of asbestos fibres for the laboratories of the National Research Council.

Co-operative researches.—Studies were carried out in co-operation with the Department of Physical Chemistry of McGill University on the following subjects: Opacity of paper, penetration of liquors into wood, pulping studies, the sorption of electrolytes by wood, the chemistry of sulphite liquors, the density of cellulose and wood, and the adsorption of vapours and gases by cellulose and wood.

VANCOUVER LABORATORY

Division of Timber Mechanics

Testing of clear specimens of British Columbia woods.—Tests of various British Columbia woods were continued, the timbers tested in the green condition having been Western birch, broad-leaved maple, and red alder.

Testing of structural timbers.—Douglas fir joists 2 in. by 10 in. by 16 ft. in selected common, No. 1 common, and No. 2 common grades were tested in the air-dry condition; these matched pieces previously tested in the green condition. The data were adjusted to supply information regarding Ukay grades for the United Kingdom.

Holding power of nails.—Tests of the holding power in wood of screws, wire nails, and box nails were continued.

Glued joints.—The strengths and moisture-resistant qualities of various glues on different species of wood were determined, a work which has led to the manufacture of one variety of casein glue locally.

Tests on timbers aged in service.—Tests on Douglas fir timbers from buildings erected, respectively, 43 and 63 years ago were carried out.

Tests of telephone poles.—Tests were completed on lodgepole pine poles, and further trials made of creosoted Douglas fir poles. The laboratory's research has also contributed to the fixing of standards for maximum fibre stress for Douglas fir and lodgepole pine poles.

Minor investigations.—Among the many minor tests made, one, at least, has resulted in the use of a Canadian species instead of a foreign species.

Division of Timber Products

Lumber seasoning.—Test shipments of lumber made to the United Kingdom, Australia, South Africa, Trinidad, and Eastern Canada indicate that lumber, properly seasoned and stowed, will arrive at its destination in good condition. Among other topics studied were the relation of length of storage to the hygroscopicity of lumber, the equilibrium moisture content of seasoned lumber in the main lumber-producing districts of British Columbia, the feasibility of air-seasoning lumber in the southern coast region during the wet winter months, the air-seasoning of lumber to conform with special specifications for shipment to the United Kingdom, the rate of air-seasoning and the moisture gradient of Douglas fir timbers and Western red cedar poles, and the relative rate of air-drying of lumber when rough and when surfaced. Air-seasoning of lumber to conform with the special specifications for shipment to the United Kingdom was studied in order to assist lumbermen in their efforts to develop that market.

Kiln-drying.—The laboratory's experimental kiln was used to determine the effect of rate of circulation on the drying of Douglas fir—information made necessary by the rapid increase in the use of mechanical-circulation kilns in the province—and experimental runs were also made to determine (1) satisfactory schedules for drying thick Douglas fir and for drying Sitka spruce used for the manufacture of aeroplane parts, (2) the feasibility of satisfactorily kiln-drying Western alder veneer, (3) the best methods of kiln-drying lumber for shipment to the United Kingdom at specified moisture contents, (4) feasibility of using water sprays for humidification in kiln-drying, and (5) the effect of certain factors on the kiln-drying of red cedar shingles. The seasoning and shipment of lumber at various mills were studied, and assistance given in connection with their seasoning practice.

Ambrosia beetles in lumber.—In co-operation with the Entomological Branch of the Department of Agriculture, an investigation was carried out to determine the time and temperature in a dry-kiln necessary to destroy ambrosia beetles (pinworms) in lumber, especially that intended for export consignment.

Sawmill waste.—The study of improved methods of utilization of sawmill waste was continued, a number of suggestions as to such methods being investigated. Many inquiries were answered in regard to the use of sawdust as a fuel.

Logging waste.—The results of the studies of logging waste in the Douglas fir and Western cedar type of the southern coast region of the province were compiled, consequent on which the Canadian Pacific Railway has requested that similar studies be made in the interior region of the province.

Significance of the coloration of Western red cedar.—Studies of the significance of coloration in Western red cedar indicated that there is no difference in the quality of light and dark wood.

Factors affecting the durability of scows.—A study was made of the life of scows and of factors causing decay in scows and a report prepared making certain suggestions to improve their durability.

General

Exhibits.—Assistance was given to the Canadian Forestry Association and the British Columbia Lumber and Shingle Manufacturers in the exhibit of forest products at the Canada Pacific Exhibition, and to the latter organization in trade extension in the Orient, and an exhibit of forest products was set upfor the annual convention of the Canadian Federation of Business and Professional Women's Clubs.

Publications.—In addition to manuscripts submitted for publication in printed form, the following reports were mimeographed and distributed: Change in Moisture Content of Kiln-dried Lumber when Shipped by Water to Various Parts of the World, by J. H. Jenkins; Relation Between the Moisture Content of Shook and the Rusting of Cans in Storage, by J. H. Jenkins and F. W. Guernsey; The Development in Kiln-drying Practice on the Pacific Coast, by J. H. Jenkins; Logging Waste in the Douglas Fir & Western Red Cedar Type of the Southern Coast Region of British Columbia, by J. H. Jenkins and F. W. Guernsey; The Prevention of Collapse in the Kiln-drying of Western Red Cedar, by J. H. Jenkins; The Occurrence and Significance of Internal Sapwood, by H. W. Eades; Shrinkage and Moisture Content Tests made in Connection with the Kiln-drying of 2-inch by 6-inch Douglas Fir Required for Trade Development Purposes in the United Kingdom, by J. H. Jenkins.

BULLETINS AND CIRCULARS

New printed publications issued by the Service during the year were the following:—

Bulletins.—82, The Mechanical Properties of Canadian Woods, together with their Related Physical Properties; 84, The Cellulose-Water Relationship in Paper-making.

Circulars.—36, Leaching Tests of Water-soluble Wood Preservatives; 37, Red Stain in Jack Pine: a comparative study of the effect of *Trametes Pini* and a second red-staining fungus on the strength of jack pine.

French edition.—L'Erable à sucre (Tree Pamphlet 14).

Bulletin 73, Tree-Repairing, was reprinted, and a revised edition of Bulletin 61, Native Trees of Canada, was in press at the conclusion of the year.

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