DEPARTMENT OF THE INTERIOR, CANADA

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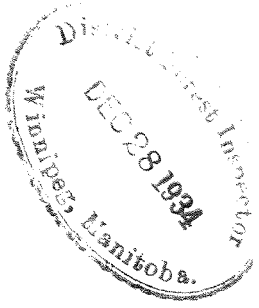

REPORT

OF THE

DIRECTOR OF FORESTRY

1933-4

(FISCAL YEAR ENDED MARCH 31, 1934)

OTTAWA
J. O. PATENAUDE
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1934

FORESTRY

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

The forests and forest industries of Canada are proving to be important factors in rehabilitation of the economic and social conditions in the Dominion. During the past year the industry has done a good deal to readjust operations and methods to meet changed conditions, with the result that production and exports have shown a marked increase over the previous year. There has been some improvement in the prices; production costs in both the lumber and the pulp and paper industries have been lowered; and new and enlarged markets have been developed abroad. All of these things have operated toward restoration of stability in the industry.

Statistics of total production are not yet available, but an increase of 86 per cent over the preceding year in the amount and value of the exports is indicative. Sales in the United States having diminished because of economic conditions and increased taxes on imports into that country, it was imperative that other markets be developed. In accomplishing this, the preferential trade agreements with the other countries of the British Empire have been helpful.

This improvement in forest industry is reflected in a greatly increased activity in woods operations. Reports received by the Bureau of Statistics from companies constituting a substantial proportion of the logging industry, in both pulpwood and saw-timber, indicate that during the winter months, October, 1933, to March, 1934, the average monthly employment was probably about 128,000, as compared with 49,000 during the same months in the preceding year. Perhaps of better use for comparison, however, are the year-long figures for employment in woods operations. On this basis, in 1933-34 the derived figure for the number employed was 84,000, as compared with 39,000 in 1932-33, and an average of 91,000 for the years 1926 to 1930. There is no doubt that employment in woods operations was stimulated greatly by the fact that the stocks of wood had run to a low ebb; the improvement was, nevertheless, noteworthy, although it is evident that still further improvement is both possible and desirable.

Indicating the stature of the forest industry of more normal times, and emphasizing the desirability of exerting every effort towards its thorough rehabilitation, it may be stated that during the period 1926 to 1930, the average number employed annually in woods operations and the manufacture of forest products was 244,000. The annual wages paid such employees averaged $249,000,000. The value of primary products, such as logs and pulpwood, was $210,000,000, and a further $372,570,000 was added to the value through manufacture. Through industrial utilization of the forest resources, therefore, $582,570,000 was added annually to the financial resources of the Dominion; and, of this amount, some $278,500,000 came from foreign countries in payment for our exports of forest products.

Obviously, an industry of such outstanding significance in our economic structure merits preservation. In common with other industries, it has during the past few years faced an unprecedented crisis. Demand for its products fell to abnormal levels, owing to decreased consumption of newsprint and other paper products and major curtailment in construction operations.

In prosperous times the market for wood and wood products is highly competitive; in times of depression it is even more so. There is keen competition, not only between the various wood-producing countries, and between the differ-

ent kinds of wood, but also with substitutes such as steel, cement, and other materials. Quality and physical characteristics are important factors in the competition as between woods, but price is by far the most important, especially in meeting the inroads of these other materials. It is imperative, therefore, that our production costs of lumber, paper, and other wood products be kept at levels which will enable them to compete with these other commodities in the markets of the world.

One of the major items of cost is that of cutting and delivering the raw material to the manufacturing plants; and this, in turn, is primarily dependent on the accessibility of the forest and the volume of the stand. Accessibility affects not only the cost of transporting the logs out of the woods, but of taking in men and supplies for the operation. The amount of wood which can be extracted with a given layout of roads and equipment influences the cost. It is of the utmost importance, therefore, that an adequate supply of timber should be maintained, and that such timber should be readily accessible to the industries that are to utilize it.

Under the past system of destructive logging, followed as it generally has been by fire in the slashings, sources of supplies have been steadily receding from manufacturing centres and transportation facilities. Sawmills have to some extent followed the timber, leaving behind deserted villages, impoverished settlements, and devastated lands. Pulp and paper mills, however, cannot be so readily moved to new locations, and the pulpwood must be transported for increasing distances. If Canadian forest industries are to continue as an important factor in world trade, adequate timber supplies must be readily available; the more accessible forests must be kept permanently in a state of systematic and continuous production.

The total annual cut for domestic consumption and export averaged about three thousand million cubic feet during the years 1926-30. This quantity of wood could readily be produced yearly in perpetuity on an area of 200,000 square miles—about one-quarter of the area in Canada now classed as potentially productive forest land. That the industries have to go so far afield for their supplies, is due to the fact that 60 per cent of the potentially productive area has been burned over so recently that the new growth is not yet large enough for pulpwood. On an additional 15 per cent the timber is still immature though large enough for some commercial products, such as pulpwood. The remaining mature timber is for the most part situated in the more remote locations.

In Canada, we are prone to boast of the wisdom of our forefathers in having retained to such great extent in public control the ownership of forest lands. Probably in no other country has this feature so strongly characterized the administration of timber lands.

If the forest industry of Canada is to the extent of 85 or 90 per cent founded upon use of a raw material which is owned by the Canadian people, obviously this ownership is a public trust, and this trust implies that it shall be used wisely and providently. Although the use of the forest resource has been allotted under various forms of tenure to those who operate industries as private concerns, in practically all cases the articles of the instruments conveying tenure provide for regulative control by governmental authority. The ownership of timberlands remains still with the people, and it is greatly to be desired that the present generation will witness the calling into legitimate play of the forest regulative functions which by law are reserved to the State. For 30, 40 or even 50 years, timber licences and leases have contained clauses which imply at least the elements of forest conservation, but unfortunately they have not been adequately enforced.

Insurance of various kinds is recognized as an absolutely essential requirement of modern business, in providing against emergencies with respect to

destructible property, buildings and other structures; to carry on business effectively, of necessity one is compelled to provide reasonable coverage. The very foundation stone of one of our greatest manufacturing industries, namely the forest, is still an uninsurable resource. Is this not in itself most convincing proof that the facilities so far provided for protection of the forest have been inadequate? Does it not mean that, in order to safeguard properly the source of raw materials for the great forest industry, more careful and more liberal provision should be made, and the effectiveness of the forest protective agencies, both governmental and private, increased? In the past, in Canada we have been prone to neglect one of the most providential characteristics of the forest, namely its power of self-perpetuation, if afforded proper protection and management; in other words, we have been inclined to "mine" the timber rather than to crop it.

Until twenty-five or thirty years ago there was perhaps some reason or excuse for this erroneous conception, in that the forests were deemed inexhaustible. In the interval we have learned the falsity of such a position; through industrial expansion we have perhaps doubled our demands upon the forests; in the same interval we have increased many times the hazards to which the forest is exposed. True, we have also increased our efforts in safeguarding the forest resource, but by no means have we done so to the extent which is necessary to ensure its preservation. That this is true, is surely evidenced by the fact above stated that the forests in general are uninsurable.

For generations the forests of Canada have been exploited as a lucrative source of public revenues. At various times, and in different parts of the Dominion, of the revenues taken from forest lands there has been returned to them in the form of protection and management amounts running from 10 per cent up to perhaps 35 or 40 per cent. The balances have found their way to the public purse, and have been expended in the construction of public works and other facilities for the convenience and well-being of the people. Obviously the forests should be expected to show a net revenue on operation, but well may we pause to ask whether any sound business has yet been conceived which could stand continuously the drain to which, as above stated, the forests of Canada have been subjected.

FOREST PROTECTION

On the whole, Canada experienced a very favourable season in respect to forest fire losses during the calendar year 1933. Weather conditions were very favourable, and this was indeed providential, in view of the economic conditions which imposed serious handicaps on protection organizations, as reflected in greatly reduced staffs and curtailed appropriations.

In Ontario and Western Canada the usual severe early spring fire-hazard did not develop, it being well along in May before fires became numerous. This condition was to some extent counteracted by prolonged dry periods during the months of June, July, and August, which last was the most hazardous month throughout the Dominion, particularly in the eastern provinces, where 70 per cent of all fires occurred.

British Columbia.—British Columbia experienced the most favourable season in the past eleven years, escaping entirely the severe early spring hazard which normally occurs in the northern and central interior of the province. Serious fire danger developed for a few days only in restricted districts. Rainfall was well above average, and well distributed throughout the year. The province reported 1,082 fires which burned over an area of 301,486 acres, comprising 35,253 acres of merchantable timber, 55,876 acres young growth, 17,680

acres of non-forested land, and 192,677 acres of cut-over lands. The total loss and damage amounted to $494,716, including $38,994 for fire-fighting costs.

Prairie Provinces.—In Manitoba, heavy snowfall during the previous winter resulted in subnormal spring fire-hazard, but the prolonged drought of previous years exerted a decided influence during the summer months, even though rain was well distributed throughout most of the province. Considerable trouble was experienced in the eastern and southeastern part of the province where lightning started many fires; owing to deep-burning muskeg and the accumulative effect of previous years of drought, the handling of these fires was difficult. In all, some 372 fires occurred, and these burned over 74,058 acres, of which 10,129 acres comprised merchantable timber, 20,195 acres young growth, 1,815 acres cut-over lands, and 41,919 acres of non-forest land. Total damage loss was $106,198, including $22,757 for fire-fighting operations. This is somewhat of an improvement over the previous year.

In Saskatchewan a new low record was established in the number of fires reported and the total loss and damage resulting. In all, 61 fires occurred, which burned over 22,764 acres, comprising 2,299 acres of merchantable timber, 11,547 acres young growth, 228 acres cut-over area, and 8,690 acres non-forest land. The total loss and damage amounted to $16,377, of which some $2,725 covered the actual fire-fighting costs.

In Alberta the heavy snowfall experienced during the winter of 1932-33, except in the southeastern portion of the province, was a helpful factor; with the exception of limited areas where the accumulative effect of previous droughts was pronounced, moisture lasted well into the summer. Although there was anxiety at times, on the whole the rain and dry spells alternated fairly well, a normal fire season resulting. Some 288 fires occurred. The area burned over was 93,764 acres, comprising 38,337 acres of merchantable timber, 20,083 acres young growth, 4,388 acres cut-over lands, and 30,956 acres non-forest land. The total monetary loss was $235,558, of which some $35,365 represents fire-fighting costs.

Ontario and Quebec.—The fire season in these provinces showed a very marked improvement over 1932, which was a bad year. In Ontario, the season opened late, with moderate spring hazard, followed by a high hazard all summer in western Ontario, which became rather extreme in August and early September over the whole of the province. General rains terminated the fire season about the middle of September. In the territory lying beyond the northern line of the Canadian National, curtailment of staff restricted fire-fighting activities to the protection of timber limits, pulp concessions, and settlements. In some cases, therefore, the provincial forest service was unable to place men on fires, with the result that no action could be taken for their control. In all, 1,922 fires were reported for this province (including three incipient fires on the federal Forest Experiment Station at Petawawa). The total area burned over was 350,008 acres, of which 94,775 acres comprised merchantable timber, 88,620 acres young growth, 42,975 acres cut-over lands, and 123,638 acres non-forest land. The total loss and damage amounted to $1,196,619, including $239,044 for fire-fighting operations. An outstanding feature of the season's experience in Ontario is the fact that 465 fires (24·2 per cent of all fires reported) were due to lightning, and these were responsible for 196,883 acres (56·3 per cent of the total area burned).

In Quebec, conditions became quite critical in May, and numerous outbreaks occurred. A condition of hazard continued throughout the months of June, July, and August, subsiding in September. Lightning fires were conspicuous in some districts. The burning of slashings was an outstanding cause, because of the opening up of new lands for settlement. Nevertheless, a decided improvement was shown over the previous year (1932) in the matter of loss

and damage. Some 1,553 fires were reported, which burned over an area of 113,358 acres, comprising 15,344 acres of merchantable timber, 12,869 acres young growth, 84,205 acres cut-over lands, and 940 acres of non-forest land. Fire-fighting costs amounted to $102,581, bringing the total loss and damage to $327,604 for this province, as against upwards of three million dollars in 1932.

Maritime Provinces.—New Brunswick experienced one of the most hazardous fire seasons since the disastrous year of 1923. The months of May and August were particularly dry, and accounted for 75 per cent of the fires which occurred during the season. In August, conditions became so serious that it became necessary to forbid, by public proclamation, all travel in the forest. Toward the end of the month, however, heavy rains relieved the situation, and conditions were normal until the end of the season. The total number of fires reported was 455, which burned over 23,668 acres, comprising 2,431 acres merchantable timber, 6,057 acres young growth, 2,841 acres cut-over lands, and 12,339 acres non-forest land. Total loss and damage amounted to $45,711, of which amount $25,594 represents fire-fighting costs.

Nova Scotia experienced little precipitation during the winter of 1932-3. The fire season started early in April and became extreme in May; during the latter month more than 55 per cent of the season's fires occurred. All ordinary forest travel was prohibited from May 19 to June 20. Conditions continued critical throughout July and August, but were relieved in September. The total number of fires reported was 470, which burned over 22,652 acres, comprising 1,941 acres merchantable timber, 3,834 acres young growth, 2,275 acres cut-over lands, and 14,602 acres of non-forest land. The total loss and damage amounted to $67,759, including $36,547 for fire-fighting operations.

General.—The foregoing remarks deal with the fire situation in general throughout the Dominion in the calendar year 1933. To complete the picture it remains only to indicate the character of the season on lands directly controlled by the federal Government.

On Indian lands, 37 fires were reported, which burned over a total of 4,720 acres, comprising 3,665 acres of merchantable timber, 845 acres young growth, and 210 acres cut-over lands. The total loss and damage amounted to $18,230, including $5,532 for fire-fighting costs. In the National Parks, 58 fires were reported as burning over 2,079 acres, comprising 231 acres of merchantable timber, 694 acres young growth, and 1,154 acres non-forest land. The total loss and damage is estimated at $4,498, including $800 for fire-fighting costs.

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TABLE I.—STATEMENT OF FOREST FIRES IN CANADA DURING THE CALENDAR YEAR 1933, AND COMPARISON WITH 5-YEAR PERIOD 1929-1933

Item	Year 1933	Average for years 1929-1933
Total number of fires	6,298	6,607
Total area burned over (acres)	1,008,557	2,853,190
Merchantable timber—		
Area burned (acres)	204,405	543,402
Timber burned (M ft. B.M.)	255,383	441,526
" (cords)	650,317	1,673,463
Estimated stumpage value	$ 1,199,305	$ 2,960,688
Young growth—		
Area burned (acres)	220,620	613,482
Estimated value	$ 454,648	$ 1,268,428
Cut-over land—		
Area burned (acres)	331,614	557,568
Estimated value	$ 187,303	$ 316,884
Non-forested—		
Area burned (acres)	251,918	1,138,737
Other property burned—		
Value	$ 162,075	$ 319,727
Actual cost of fire-fighting	$ 509,939	$ 900,072
Total damage and loss	$ 2,513,270	$ 5,765,800

In table I it will be noted that the total number of fires reported in Canada during the year 1933 is 6,298. While the number of fires exceeded slightly the number in the year 1932, there was, fortunately, a great reduction in the losses sustained. Merchantable timber to the value of $1,199,305 was burned, as compared with 1932, when losses exceeded five million dollars. The value of young growth lost in the past year approximated one-third of that destroyed in 1932. The total loss and damage incurred was $2,513,270 during the past year, as compared with $7,830,070 in 1932.

TABLE II.—STATEMENT OF FIRES BY CAUSES FOR 10-YEAR PERIOD 1924-1933, IN CANADA

Cause	Year										Total	Per cent	Average annual number of fires by causes, 1924-33
	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933			
Camp-fires	1,014	944	999	669	814	1,332	1,256	1,540	1,302	1,202	11,072	19·1	1,107
Smokers	480	531	513	369	500	856	762	937	809	893	6,650	11·5	665
Settlers	1,018	692	763	532	728	769	966	1,095	1,385	1,265	9,213	16·0	921
Railways	1,031	711	1,129	574	752	1,011	731	624	354	312	7,229	12·5	723
Lightning	476	978	823	716	485	1,167	1,482	880	651	940	8,598	15·0	860
Industrial operations	269	257	247	129	170	206	160	134	91	139	1,802	3·1	180
Incendiary	229	204	167	95	230	387	521	673	746	511	3,763	6·5	376
Public works	31	28	60	54	35	80	98	97	73	11	567	1·0	57
Unclassified	215	431	260	130	227	240	276	367	243	300	2,689	4·7	269
Unknown	861	714	729	337	320	637	553	607	641	725	6,124	10·6	612
Total	5,624	5,490	5,690	3,605	4,261	6,685	6,805	6,954	6,295	6,298	57,707	100·0	5,770

Table II indicates the agencies responsible for more than 57,000 fires which occurred in Canada during the past ten years, causing loss and damage of over 52 million dollars. This figure takes no account of damage to soil, cost of operation of forest-protection services, total or partial cessation of forest industry in the districts affected, or of the inevitable potential loss in wage values and production caused by fires. It will be observed that 15 per cent of these fires were due to lightning or natural causes and the remainder—85 per cent—to human agencies. The picture in this respect changes little from year to year,

but it may be said that in 1933 the area burned was one of the smallest on record. Monetary losses, also, were correspondingly lower. While, for the Dominion as a whole, weather conditions were fairly favourable, nevertheless great credit must be given to the forest fire-protective organizations which strained their personnel and resources in an effort to keep such losses to a minimum, notwithstanding the handicaps under which they have been placed owing to economic conditions which have prevailed for several years.

With the approach of better times, it is of special interest to note the prominent part which the forests of the Dominion are playing in industrial recovery. As thousands and tens of thousands of employees are being re-absorbed by the forest industries, the importance of the forest in our social and economic development will surely be impressed with greater force upon the public mind. It is to be hoped, therefore, that the general public, particularly those who make use of the forest, will more fully recognize the need for co-operation in, and support of, the work of the various services and agencies whose duty it is to protect the forest resources of the Dominion.

Fire-hazard Research

One of the most useful and highly appreciated activities of the service consists in the investigation of forest-fire hazards, which includes a detailed study of the effect of the various meteorological factors which operate to increase or retard the danger of fires occurring and spreading, and the relationship of these to the inflammability of materials composing the forest. Fundamentally, the purpose of the investigations is to enable the making of reliable forecasts of the liability to fires, by precise measurements of rainfall, evaporation and relative humidity. The final results take the form of tables from which, for a particular forest type, it is possible to plot continuously, throughout the fire season, a graph which gives clearly the index of inflammability.

The importance of this work lies in the fact, that the results may be put to very direct practical application in controlling the movement and allocation of forest personnel. Hitherto, such matters were left almost entirely to personal judgment of the supervisory staff, often with lamentable results.

These investigations have been under way at the Petawawa Forest Experiment Station for several years. During the past year, studies were continued in the mixed hardwood and the open grassy subtypes. A new project was undertaken in an area of pure white pine to round out the work previously done in the pine types.

Considerable time was spent on a critical check-up of the accuracy which may be expected from the fire-hazard tables. It was found by comparing the time of occurrence and behaviour of a large number of fires which actually occurred over a period of five years, with the degree of hazard as worked out from the tables for each day of the period studied, that the tables indicated the hazard with remarkable accuracy.

Analyses of data collected in previous years and several improvements in technique have been made. During the year, there has been developed a circular slide-rule which embodies the data contained in fire-hazard tables, and which will greatly speed up and facilitate the working out of the daily degree of fire-hazard.

In pursuing these investigations, the aim of the service has been first to thoroughly work out the technique of fire-weather forecasting, using the facilities of forest experiment stations as a base, and as rapidly as possible to make the results available for the use of other services and fire-protective agencies.

White Pine Blister Rust

This disease first appeared in British Columbia on imported nursery stock about 1910, and in Ontario about 1916, and has spread so widely in the white pine areas of Eastern Canada and British Columbia that it threatens the very existence of this highly important tree species.

When it is considered that the total white pine stand approximates eleven billion feet, board measure, of which 9·3 billion is Eastern white pine and 1·7 billion Western white pine, the possible losses involved in the ravages of the disease are apparent. At reasonable stumpage figures, the value of the white pine resource is $55,000,000, but this does not take into consideration the extensive areas of young growth on which the future of the white pine sawmilling industry must be based, and whose potential value is estimated at a further $50,000,000.

The white pine blister rust is an organism having a complex life-history, one phase of its existence being spent on the white pine tree, and the other on the leaves of currant and gooseberry bushes. The control of the disease is complicated by the fact that the cultivated black currant is the most susceptible host and must be completely eradicated within at least a mile of the nearest stand of white pine, if control is to be effective.

From the economic standpoint, the question of cost is very important. In order that representative figures might be obtained, the Forest Service conducted an experimental campaign on the Petawawa Experiment Station during the year, using unemployment relief labour. Results were fairly satisfactory, but indicated clearly the necessity of utilizing the services of trained and experienced workers, if effective control is to be obtained at costs equivalent to those secured in the eastern United States. In that country much work has already been done at a cost of approximately 25 cents per acre.

The situation calls for co-operative action as between the federal and provincial governments on the one hand, and interested industry on the other.

FOREST EXPERIMENT STATIONS

Of outstanding importance during the year was the co-operative arrangement with the Department of National Defence for the development of forestry experimental areas, the labour available at unemployment relief projects operated by that department being utilized.

Forestry experimental areas constitute what might be called "field laboratories," in connection with the series of forest experiment stations embracing each of the main forest regions of Canada. They provide facilities for detailed scientific investigation of the rates and conditions of growth of Canadian tree species and forest types, their object being to establish the principles underlying proper regulation of the cut and provision for regeneration of the most desirable species. The acquirement of fundamental data of this nature is an essential preliminary to the institution of management of timberlands on a basis of sustained yield.

The work of a forest experiment station falls into two main categories: (1) that conducted on permanently established experimental areas under complete control and administration of the Forest Service; and (2) work conducted on other areas under co-operative arrangements with provincial authorities, timber-holding corporations, firms, and individuals.

The forestry experimental area is selected in a location which is as far as possible typical of the growth conditions of the region in question. Obviously, however, no one area can provide all the varying conditions to be found within the broad confines of a main forest region; consequently, the complementary investigations are undertaken on a co-operative basis for the purpose of obtaining data not procurable on the forestry experimental area proper.

The investigations are based primarily on the establishment of carefully selected sample plots, each plot representing the average condition which it is proposed to study. The plots are of two kinds: (*a*) permanent sample plots, and (*b*) temporary or single examination plots. On permanent sample plots every tree is carefully measured and mapped precisely, and a detailed description is recorded. Remeasurements are made at five-year intervals, the increase in size and volume, less losses due to decay and mortality, representing the growth of the stand during the period. Certain series of plots are subject to various cultural treatments, such as thinning and logging under different methods. The results both with respect to increased growth-rate and presence of seedlings to form the new crop are carefully noted and the proper deductions made therefrom. Single-examination plots are for the purpose of securing accurate data with respect to conditions on the ground in any particular locality at a given time; in this case growth-rate is determined by means of increment borings on the trees on the plot, the width of the annual rings being thus ascertained and recorded.

A second feature of experiment station work is the establishment of demonstration cutting areas wherein the results of research and experiments may be given practical application and made available to lumber operators and to the public as a whole. On such areas, thinning operations and logging under forestry principles are conducted on a larger scale. Particular care is taken to dispose of the slash and debris in various ways, and complete costs of every phase of the operation are ascertained.

The underlying idea of forest experimental work, therefore, is to provide the maximum possible contribution towards the solution of the problems arising in the proper handling of the main types of timber with which the forest industry in Canada is concerned. In order that the results obtained may have the widest possible usefulness, certain requirements must be recognized in the selection of the forest experimental areas: (*a*) there should be a good market for all timber available for disposal; (*b*) the area should be reasonably accessible to the general public, so that the fullest publicity and understanding of the problems under investigation may be secured; (*c*) the area must contain a fair representation of the types of timber occurring in the region which it represents; and (*d*) the area must be susceptible of adequate protection from fire in order that the outlay and results of the investigative work may be preserved.

The initial forestry experiment station was established near Petawawa, Ontario, some seventeen years ago. It is situated in the white and red pine and mixed hardwoods region, is representative of a large region of the provinces of Ontario and Quebec, and is exceptionally well adapted to a study of the problems relating to the management of these and related species. The organization has developed as a co-operative undertaking with the Department of National Defence, the forestry area being a portion of the Petawawa Military Reserve assigned to the Forest Service for administration and experimental work.

As a base for its operations in the Maritime Provinces, the Forest Service established an experimental area in New Brunswick. Through co-operation of the provincial authorities some 68 square miles lying to the northeast of Fredericton, was transferred to the Dominion. Of this area, some 36 square miles is for forest experiment work, the remainder being for military training purposes. Though most of the forestry area has been cut over or burned over in times past, it is all potentially forest land, and it is largely stocked with young growth of various timber types and age-classes. It is admirably situated with respect to markets; it is readily susceptible of fire protection; and from the standpoint of demonstration it is very accessible to the public, being bisected by the Richibucto Road, which is being developed as a main highway.

As a base for forestry investigations in the middle Quebec region, the Department of National Defence has assigned the northerly portion of the Valcartier Military Reserve, north of Quebec city, as a forestry experimental area. Although small in size, covering only about 7½ square miles, it contains interesting forest types, typical of large districts in Quebec and Ontario. Open spaces provide an excellent opportunity for artificial regeneration experiments. The work of the station is supplemented by investigations at other points.

Through co-operation of the Government of Manitoba, an area of 37 square miles has been assigned to the Dominion for forest experimental purposes, in the Duck Mountain forest reserve. Timber types are typical of conditions met with in the forest regions of the Prairie Provinces, and the area will constitute the main base for investigations in the forested sections of those provinces.

In British Columbia, negotiations have been under way for some time for the acquirement by the Dominion of an area of approximately 40 square miles, now a provincial forest reserve, on East Thurlow Island, containing timber types representative of the important timber stands of the lower Coast region of British Columbia.

The necessity of finding suitable projects for unemployment relief operations provided an excellent opportunity for the development of these forest experiment areas. Woods employment provides almost ideal working conditions for the single homeless men who are the immediate charge of the Department of National Defence, and has the added advantage of removing them from the large centres of population. Prior to the depression they had been engaged in a wide variety of occupations; comparatively few of them had previous experience in forest activities of any kind.

The forestry projects included tree-planting operations and the construction of forest roads and other improvements, also timber operations, including not only logging under forestry principles, but the manufacture of timber through the use of portable sawmills. The product of these mills has been utilized in construction of buildings, bridges, highway culverts, and other structures. The unique advantages of conditions wherein the whole range of forestry practice, including logging and manufacture, can be combined in the one operation presents unusual opportunities from the standpoint of experiment and research.

The general principles observed in the selection and establishment of forest experimental areas have been outlined. While these stations afford facilities for research in several phases of forestry, the principal purpose for which they are established is to permit the conduct of investigations in silviculture and scientific forest regulation. The work performed during the past year, in this field, may now be reviewed.

Petawawa Forest Experiment Station

Silvicultural and management problems and research projects have now been oriented to the requirements of the working plan for the area. The plan provides that a certain volume of mature timber, not exceeding the annual growth, may be removed each year. In removing this timber, various recognized silvicultural cutting systems are being practised. The relative value of each as a means of improving growth of the remaining stand and inducing natural regeneration of desirable species forms the basis of investigation.

Investigation of the relative value of various silvicultural cutting systems in pine types where second-growth white and red pine is already well established was initiated under three cutting systems as follows: first, on an area of 40 acres the complete overstory of jack pine six inches and over was removed; second, on an area of 30 acres the system of clear-cutting in strips, respectively, one chain wide, and two chains wide was practised, the control strips being left untouched; third, on 70 acres, trees were selected and marked to leave sufficient

of the overstory crowns to shade 40 per cent of the ground at mid-day. Five other areas, varying from 30 to 100 acres, were marked under different degrees of selection.

Altogether over a million feet board measure, principally jack pine, was carefully marked and removed from these areas. Cutting operations were performed by crews from the relief camps, working under the technical directions of forest officers. Each of these areas was carefully surveyed for a detailed record of the stands and reproduction prior to the cutting, and will be resurveyed and recorded immediately following the cutting, and thereafter at five-year intervals.

From stands of mixed poplar and pine, 2,000 cords of poplar match-stock was removed during the winter. The effect of release of the pine will be observed. Altogether the equivalent of some 5,000 cords of material was removed from the forest area during the year, an amount well within the estimated annual increment.

Twenty permanent sample plots established in previous years were remeasured; the data have now been compiled, and for some the results have been analysed. These plots were designed for the study of yield on cut-over areas, for the effect of thinning, and for regeneration studies.

Analyses were made of the results received from a group of plots, nine series of three subplots each, established in 1922 to study the effect of seed-bed conditions upon germination and growth of seedlings. One subplot of each series had been left undisturbed, from the second the litter and humus had been raked, and from the third the litter and humus had been burned. On each of the twenty-seven subplots identical quantities of spruce seed were sown. The excellent germination results on the plots where the mineral soil was exposed by raking, as compared with the almost complete failure on the plots of undisturbed litter, indicate very clearly the desirability of disturbing litter in logging operations during a seed-year. Although the number of seedlings found on the burned plots was much lower than on the raked plots, the growth-rate on the former was about double that on the remainder of the plots. This may be due in part to absence of root competition, but reduction in acidity brought about by addition of wood-ash has undoubtedly had an effect.

Analyses were also completed of two other series—ten plots in all—established in 1921 and 1922 on an area from which poplar match-stock had been cut in winter, the project being to study the development of sprouts and suckers. After ten years' observation it was found that when these poplar stands were severely opened, by the removal of ten or twenty cords per acre, sprout reproduction during the first year averaged over 20,000 per acre. During the second year, however, over one-half of them disappeared. By the tenth year the stock was reduced to 1,000 or 1,500 which had reached the size of small trees, and another 1,500 small sprouts, which will probably disappear in a year or so. Little more than 10 per cent of the original reproduction survived ten years, and probably will not occasion serious competition to conifer seedlings beyond that period.

In addition to the work at Petawawa five other permanent sample plots at Goulais River, Algoma district, were remeasured. These were established in co-operation with the Spanish River Pulp and Paper Company in 1920 on cut-over and burned-over pulpwood lands.

During May, 45,000 red pine and 40,000 white spruce were set out at Petawawa, in an abandoned farm area, with the object of investigating the relative value of the two species on a light sandy soil. During the same period, about 700,000 red pine transplants, kindly supplied by the Forestry Branch of the Department of Lands and Forests of Ontario, were planted out. Here, again, labour was recruited from relief camps. A survey of the areas planted,

made in the autumn, indicated that about 80 per cent of the trees had become established, an excellent result when the unfavourably dry summer season is considered.

At the close of the planting season, road improvement and construction was undertaken as a relief project. One crew working in the Highview area converted ten miles of wagon road into motor road, from the Trans-Canada highway to Highview Point on the Ottawa river. On this project two excellent new timber bridges were constructed. A second project undertaken was a new road from headquarters at Corry lake to Racehorse camp on the Petawawa river. When completed this road will reduce the distance from eleven to approximately eight miles; it crosses country otherwise difficult of access, an important matter in event of fire. It is expected that the remainder will be completed this year. A third bridge, crossing the Petawawa river, was erected at the Racehorse camp, also a relief project; the valuable peninsula between the Petawawa and Barron rivers has thus been made accessible by truck as well as by water. The surveying and engineering design for these bridges as well as general supervision of the construction, was done by the Forest Service. The Racehorse bridge covers a span of 260 feet and is a particularly creditable piece of work.

In the matter of timber sales, the year was a very active one at the Petawawa station. In addition to the volume of timber removed under the annual felling budget for the forestry area, some 4,000 cords of pulpwood and half a million feet of saw-timber were removed from the military area, on which timber administration is carried on by the Forest Service for the Department of National Defence. As a matter of policy, to distribute the labour as a relief measure amongst the settlers, the timber was sold under permits not exceeding 100 cords each. The amount sold to any one man was restricted to 200 cords. A total of 103 permits was issued during the year; and, in addition, some 20 permits for small amounts of fuel-wood were issued.

The two portable sawmills operated as a relief project cut half a million feet of pine and spruce during the summer, giving employment to a large number of men in woods and mill. Winter operations in connection with working plan experiments already referred to produced about half a million feet of pine (mostly jack pine) to be summer-sawn at the two mills during 1934.

The Acadia Forest Experiment Station

Although the season was well advanced before the experimental area was made available, satisfactory progress was made with the detailed survey which will form the basis for a working plan of research and silviculture.

As a relief project, the construction of roads through the reserve and the thinning of young mixedwood stands—the thinnings used to provide fuel-wood for the relief camps—afforded employment to several hundred single men during the fall and winter months.

During the summer a total of nineteen permanent sample plots—established to study yield, the effect of girdling hardwoods to release conifers, and the nature of reproduction following selection, shelter-wood, group, and clear-cutting methods—was remeasured. In 1923 an experiment was started in co-operation with the National Research Council and the New Brunswick Forest Service to determine the possibilities of obtaining reproduction on waste lands by direct seeding methods. These experimental plots were remeasured this year.

A summary report covering the results of the first remeasurement of the woodlot sample plots in Nova Scotia was issued.

Valcartier Forest Experiment Station

In making the working-plan survey of the Valcartier Forest Experiment Station, difficulty was encountered in determining the station boundaries, which necessitated the re-running of certain lines by an official land surveyor. The survey and map have been completed, and with these as a basis a program of research projects for a period of years will be planned. Since a great proportion of the wooded area contains mature hardwoods, cutting experiments can be started at once with a view to regenerating the forest with a greater percentage of conifers.

The cutting of the boundary lines and fireguards, together with fence and road construction, provided work for a large number of men from the unemployment relief camp. The planting of open lands was also undertaken as an unemployment relief project. About 200,000 white pine and spruce seedlings were planted, and 120,000 seedlings too small for planting out were placed in transplant beds to develop for another year or two. The planting stock for this project was kindly supplied by the Quebec Forest Service.

The Duck Mountain Forest Experiment Station

The Duck Mountain experimental area and immediately adjoining land was photographed by the Royal Canadian Air Force, and the Topographical and Air Survey Bureau prepared an aerial type-and-base map. From these the location was determined of the roads necessary to make the area accessible, and the site for a lookout tower selected.

The men in the unemployment relief camps during the winter were employed on road construction. They also got out logs for the erection of administration buildings. The boundaries of the station were surveyed by a surveyor of the Topographical and Air Survey Bureau.

The study of forest sites made during the previous fiscal year was summarized and prepared in the form of an interim report. The report showed the necessity of further data, which were collected last summer, and a complete report is in preparation.

The work in Alberta during the past year has been concerned, in the main, with a continuation of site studies in connection with the growth of lodgepole pine on the east slope of the Rocky mountains. Previous work has demonstrated that site (the wood-growing potentialities of any forest situation) could not be assessed with sufficient accuracy for many purposes by the old method of measuring height growth in a given number of years. It was found that the density of the stand, or the number of trees per acre, had an appreciable influence on the rate of growth of both height and diameter, and must, therefore, be given primary consideration when evaluating site.

British Columbia Forest Experiment Station

Following the tentative selection of the Thurlow Island forest experimental area, an aerial survey was made and a type map prepared. Based on this map a program of road, trail, and bridge construction was drawn up to provide employment as a relief project.

Considerable time was spent on seed collection and extraction, largely on a repayment basis, for the British Forestry Commission and the Government of Northern Ireland. In general, the cone crop was very poor, and the yield of seed per cone was also very light. The seed per bushel of cones was only about one-third that obtained in the average year and in consequence seed was expensive.

Careful researches and investigations were made of the germinating characteristics of the seed of the commercial tree species of the Coast region.

This is an important matter in the determination of yields for collections made on behalf of Empire authorities. Special apparatus was designed for testing germination in an endeavour to secure standardization of results. This work has proved of outstanding interest to the countries of the Empire using Canadian tree seed for reforestation purposes.

FOREST ECONOMICS

Forest products constitute about one-quarter of the exports of Canadian products and only about three per cent of the imports for consumption. The trade in forest products during the years 1926-30 provided a favourable balance, averaging $240,872,438 annually, the exports being valued at $278,500,721 and the imports $37,628,283. During the last four fiscal years the values of both exports and imports have been greatly reduced, but the relative position of forest products in relation to the total trade has not changed materially.

The value of the exports and imports of wood, wood products, and paper, exclusive of books and other printed matter, has been as follows:—

TRADE IN FOREST PRODUCTS

Fiscal Year	Exports		Imports	
	Value	Percent of Total	Value	Percent of Total
	$		$	
1929-30	288,101,089	25·7	42,820,298	3·4
1930-31	229,408,198	28·7	29,905,528	3·3
1931-32	175,004,693	30·4	19,398,843	3·4
1932-33	120,317,717	25·4	11,337,647	2·8
1933-34	142,581,016	24·6	10,985,360	2·5
Average	191,082,543	26·9	22,889,535	3·2

Lumber

Perhaps the most significant feature of the year has been the development of new markets to replace business lost in the United States. The decreased consumption and tariff increases continued to exercise a marked effect on Canadian lumber exports to the United States. Between 1926 and 1930, our exports to that country averaged 1,450 million feet board measure per year. In the fiscal year 1932-33 exports had fallen to 236 million feet. During the past fiscal year, however, there was a limited recovery to 324 million feet.

Confronted also with a sharp reduction in domestic consumption, the Canadian lumber industry faced an extremely critical situation, and it was necessary to seek and develop other outlets. The trade agreements resulting from the Imperial Economic Conference in 1932 began to bear fruit during the following year. Since March, 1933, there has been a marked increase in the exports to the various parts of the Empire. Exports of lumber to the United Kingdom increased 188 per cent over the preceding year, and exports to British countries as a whole, 121 per cent. The trade with Japan decreased slightly, but the exports to China were more than doubled. Exports to all countries increased 86 per cent in both quantity and value over the previous fiscal year. This increase in trade was due in a large measure to the efforts of the industry in reducing costs of production, and to the effective merchandising campaign conducted, especially in the United Kingdom, Australia, and China. In addition to the Canadian Trade Commissioners and the special representatives of the industry, a number of the lumbermen from British Columbia and the eastern provinces visited Great Britain to study personally the requirements of the trade and to establish connections.

In spite of the advantage embodied in preferential tariffs in British countries, usually about 10 per cent, the industry was faced with the necessity of selling at prices 35 to 40 per cent lower than prices received for exported lumber during the period 1926-30, in order to meet the competition of northern European countries. This entailed drastic reduction in the cost of production. Most of the provincial governments assisted by reducing the royalty on timber cut from Crown lands, and labour costs were considerably reduced. These, with other economies in operation, enabled the industry to meet the emergency.

It is not to be expected that costs can be kept down permanently at the expense of wages or of governmental revenues. The permanent solution of the problem of meeting foreign competition appears to lie in the reduction of transportation costs in logging operations by protecting, developing, and managing under a sustained-yield program forests on the more readily accessible lands.

Pulp and Paper

The pulp and paper industry experienced a similar reduction in both volume and value of trade. Normally dependent on exports for the disposal of from 80 to 85 per cent of its products, and on the United States for over 70 per cent, the general business depression in that country seriously affected the industry in Canada. Keen competition for the limited demand not only within the industry on this continent, but also with European countries, resulted in the falling of newsprint prices to the lowest point in twenty years. Overexpansion of the industry in the preceding decade aggravated the situation, necessitating the suspension of operation in several plants and the curtailment of production in others.

The exports of newsprint, the principal product, dropped from an average of 2,133,689 tons, valued at $132,130,559 ($61.93 per ton), during the period 1926-30, to 1,662,984 tons, valued at $74,136,863 ($44.58 per ton), in 1932-33. Although in 1933-34 exports of newsprint increased to 2,024,057 tons, their value decreased to $73,238,482 ($36.18 per ton). Exports of newsprint to British countries increased from 147,769 tons in 1932-33 to 220,090 tons in 1933-34, owing chiefly to increases in the trade with the United Kingdom and Australia. The total value of the exports of pulp and paper increased from $94,956,244 to $102,143,167.

Newsprint production reached its lowest point for the last seven years in February, 1933, when only 125,437 tons were produced. Since that time, there has been a fairly consistent increase in the monthly production resulting in a total of 2,178,056 tons for the year under review, as compared with 1,827,187 tons during the previous year. Though this is still considerably below the peak of production of 2,725,331 tons in the calendar year 1929, it is nevertheless encouraging. The precipitous decline of recent years has certainly been arrested, and there is evidence of substantial recovery.

National Inventory

One of the primary activities of the Economics Division is the conduct of the national inventory of forest resources. This program of work, which was initiated in 1929 and originally planned as a five-year program, has been necessarily slowed down by reason of economies imposed during the depression period. During the year, however, a report on the forests of Manitoba by J. D. B. Harrison, B.Sc.F., was issued as Bulletin No. 85 of this service. In addition to a comprehensive estimate of the forest resources, the report con-

tains a historical review of the administration of the forests and their economic value, a description of the forest conditions in the different parts of the province, and a discussion of the climatic, soil and other factors which influence the distribution and growth of the various forest types.

From the point of view of future supplies, the situation in Manitoba, so far as conifers are concerned, is critical, since almost two-thirds of the young growth originated after a period of exceptional fire losses extending from 1885 to 1896. Under growth conditions existing in the province, little wood can be expected to mature within the next fifty years. After that, however, there should be a good supply, provided the growing stock is adequately protected in the interval. The present normal annual cut is equivalent to 285,000 cords and the average annual loss from fire is 165,000 cords, making a total annual depletion of 460,000 cords. The accessible merchantable stands and advanced second growth justify an annual depletion not exceeding 350,000 cords. Under these conditions a serious shortage of softwood is inevitable unless the depletion is reduced. This can be attained only in one of two ways, namely, either by curtailment of utilization or reduction of fire losses. The imposition of any serious reduction in the allowable annual cut would involve a dislocation of existing industries, and it appears, therefore, that the practical and effective solution of the problem lies in more effective forest protection. With this should be combined the adoption of cultural methods for increasing and improving the unit production of wood per acre obtainable through the practice of scientific forestry.

Work on the forest inventories of Saskatchewan and Alberta has been confined by the exigencies of staff and funds available to the compilation and analysis of data already collected. In this connection mention might be made of the fact that a vast amount of valuable information on the forest resources of these provinces is available in aerial photographs and can be extracted as soon as staff is available to undertake the work. Particularly as regards Saskatchewan, the inventory can be practically completed as soon as the photographic material is worked up.

The inventory of the province of New Brunswick is nearing completion. A large amount of valuable information has been collected through the co-operation of the provincial authorities, the timber owners, and the licensees. This information, combined with data from rate-of-growth surveys conducted by the Service in previous years, will make it possible to produce a comprehensive report on the forest situation in that province.

Aerial Photographic Survey and Research

Substantial progress has been made in the preparation of a bulletin descriptive of the methods involved in the use of aerial photographs for forestry purposes. This includes not only the delineation of forest areas but the means adopted to obtain tentative estimates of the content of timber stands. During the year, the exceptional value for forestry purposes of oblique photographs taken at a steep angle has been demonstrated. Such photographs have been found particularly suitable for the interpretation of forest conditions, as they permit the measuring of the height of the timber directly. In addition the same scale can be secured from photographs taken at higher altitudes, and all of the photograph can be utilized for mapping purposes.

A beginning has been made in tests of infra-red photography, as applied to forestry. It is expected that the tone variations of the differing shades of green of tree foliage can be utilized in the classification of timber types and in timber estimates.

Forest-classification maps prepared from aerial photographs were completed covering some 1,800 square miles, including the areas set aside for forestry experimental purposes in Manitoba and British Columbia.

The Lumber Industry in the Prairie Provinces

References have been made to the exhaustive practices which have characterized timber exploitation generally in Canada. To this, the forested sections of the Prairie Provinces have been no exception. Not so many years ago, several large sawmills were in active operation, but with the waning of timber supplies some of these have disappeared and others have been forced to reduce their output.

Notwithstanding a general belief that the Prairie Provinces are essentially agricultural, a large proportion of the lands in these provinces is wholly unsuited to that purpose; for a very substantial part of the lands the only economic use lies in the production of timber. Moreover, the region is one of extreme climatic conditions, and consequently the continuance and even the extension of forest cover would be desirable if for no other reason than its beneficial effects on living conditions.

From a strictly utilitarian point of view, however, notwithstanding the fact that a large percentage of the prairie lumber requirements are supplied from British Columbia, something can and ought to be done to maintain a forest industry of reasonable dimensions in the prairie region; otherwise, a large part of the land area will remain wholly unproductive.

A beginning was made in an economic study of the lumber industry of the three provinces. The problem is regional in scope. The initial step was to secure a complete classified list of mills, showing their location and productive capacity. Such information, combined with a study of timber operations, and an analysis of timber available, including the rate of increment, will permit of conclusions leading to stabilization of the timber industry of the region. In the project, the forest services of the three provinces are co-operating, as also are other organizations interested.

The Forest Products Laboratories of Canada

Forest-products research in Canada 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. The last of these carries on investigations of certain problems of special interest to the lumber industry of British Columbia that can be dealt with more expeditiously and economically in a local laboratory than in the main laboratories.

In the three laboratories service to the wood-using industries was well maintained. Most of the problems engaging their attention were undertaken at the request of particular branches of the wood-using industry, and most valuable assistance given by the industry to the laboratory through grants, contributions of material and equipment, and in other ways. In spite of continued unsatisfactory economic conditions in the industry, demands for technical assistance continued at a high level; particularly noticeable was the great increase in the requests for publications of the laboratories, which this year were more than double the number received in any previous year.

Details of the principal problems engaging the attention of the laboratories follow.

OTTAWA LABORATORIES

Division of Wood Preservation

Creosote treatment of green yellow birch, hard maple, and beech ties.—As reported last year, 200 ties of each species—a total of 600—were treated in the green condition and stacked in the yard in order to determine the degree of checking after treatment. The ties were examined in September, 1933, and it was found that the beech ties checked severely and should not be treated green. The yellow birch, however, showed very promising results, and indications are that when it is impossible to secure air-seasoned material the use of artificial conditioning in the treating cylinder may be considered. All these species are still under observation.

Determination of arsenic in treated wood.—Arsenic is used to a considerable extent as a wood preservative, but no method for the accurate determination of this substance in treated wood had been developed. As a result of experimental work at the laboratories a very satisfactory method has been evolved. This method is successful when the quantity of white arsenic (As_2O_3) present is as low as 0·2 per cent of the weight of the dry wood. Briefly, the method is as follows:—

The samples of finely divided wood are digested with concentrated nitric acid, which oxidizes the arsenic to the pentavalent state. The arsenic is then precipitated as magnesium ammonium arsenate, which is separated by filtration and washed. Cuprous chloride and hydrochloric acid are added to the magnesium ammonium arsenate, and on distillation the arsenic is evolved and condensed as arsenious chloride, in which form it is determined by titration against a standard iodine solution.

The method of analysis was tested by adding known weights of arsenic to varying quantities of sawdust, and the arsenic then determined. For nine analyses carried out with white pine and sugar maple, the average error was 5 parts per 1,000 parts of the arsenic added.

Pencil Wood.—The work on this project was continued intermittently during the year. A report was received from an English pencil company with reference to the stained and waxed slats of Western red cedar from the interior of British Columbia submitted during the previous year. This company reported that two batches of the slats submitted were closely similar in quality to the California incense cedar slats.

Tests were made on the sawing of green Eastern cedar logs either directly into green pencil slats or into planks of $2\frac{1}{2}$ inches in thickness. The green pencil slats were seasoned indoors in less than a week, and the $2\frac{1}{2}$-inch planks were air-seasoned out-of-doors in two months (April and May). No wet pockets were found in the small amount of material handled. It was found that well-seasoned planks could be better and more economically sawn into pencil slats than green logs.

A considerable number of tests was carried out on the waxing of pencil slats. The wax was applied to part or the whole of the surfaces of the slats—in either the wet or the green condition—(1) by total immersion for several minutes, (2) by dipping of part of the slats for an instant, or (3) by smearing it over part or all of the surfaces. Penetration of the wax into the interior is effected by keeping the slats for several days at a temperature of about 70° C., which is above the melting point of the wax. By extracting with benzene, determinations of the percentages of wax at different points of the interior of the slats were carried out. As a result of this work it was concluded that best results were obtained by a total immersion of the slats in hot wax for 10 or 15 minutes, and that the penetration was more uniform when the waxing was carried out on well-seasoned slats.

Further waxing tests showed that the total amount of wax absorbed per slat was approximately the same for waxes of varying melting points, the conditions of treatment for all waxes being the same, but that the penetration was more uniform in wax with a low melting point.

Commercial production of stained and waxed Western red cedar slats has been started in British Columbia, and it is possible that this business will develop into an important industry.

Treating the ground-line of standing poles with creosote.—Tests were started in co-operation with a power company on a method of treating the ground-line of standing poles with creosote. The process suggested by the commercial organization which is co-operating in the tests consists of fastening a length of lead pipe, $\frac{1}{2}$-inch in diameter, around the pole 6 inches below the ground-line, one end being closed and the other end connected to a container which holds about half a gallon of creosote. The creosote is slowly fed to the sapwood through small tapered wooden dowels spaced 2 inches apart. To place the dowels, a hole is formed through the lead pipe and into the pole by means of a tapered steel punch which is withdrawn, and the dowel driven in with a light hammer.

Wood treatment with copper-arsenic.—Sections of two hemlock and two cedar poles treated by a special copper-arsenic process were received for test. In this process a cap attachment is affixed to the butt of a pole, and a preservative solution is forced along its length. It was requested that determinations be made of the toxic material present in the sections which were taken along the length of the poles at intervals of five feet.

Duplicate analyses for copper were carried out on each section. Results indicate that there was little or no preservative in the tops of the poles and that the distribution was not sufficiently uniform to protect the wood.

Butt treatment of poles and fence-posts.—Experiments have been carried out with a view to developing a cheap method of butt-treating telephone poles and fence-posts. Studies have been carried out on the travel of moisture in the sapwood of round timbers when used as poles or posts. It would seem that there is a flow of moisture from the ground into the butts of the poles, and that this moisture flows up the sapwood and eventually evaporates from the portion above the ground-line. This travel of moisture is, of course, greater in poles which are placed in wet soil, and in regions of low rainfall the travel of moisture is small. The flow of moisture has been traced by setting posts in the ground in tin cans (nailed to the butt) containing water-soluble salts. After a year's exposure it was found that the salts (zinc chloride and copper sulphate) had climbed up the sapwood to the top of the posts, that no salt remained in the tins, and that the concentration of the salt in the wood above the ground-line was greater than the concentration in the wood below the ground-line. If this climb of the salt continued, as it probably would, in time there would not be sufficient salt left below the ground-line to inhibit decay. In order to utilize the climb of moisture in poles or posts as an aid to treatment and to avoid the depletion of preservative below the ground-line, experiments are now being made by boring holes longitudinally in the sapwood at the butt and filling the alternate holes with a salt which will combine with another salt placed in the other holes, to precipitate a toxic insoluble salt below the ground-line by a fanning out, or diffusion, of the salts during the climb up the sapwood from the holes in the butt.

Muskiki Brine.—Canada possesses a considerable number of salt lakes, especially in the Prairie Provinces, and the Department of Natural Resources of the Canadian National Railways is interested in investigating the possibility of preserving railway ties with these saline waters, a test treatment having been carried out with jack pine ties. These ties were immersed in the saline waters of lake Manito, from September, 1920, to May, 1921, and placed in track on June 5, 1921. One tie was removed because of decay in April, 1933, the other ties being then in good condition. The life of an untreated jack pine in this locality is estimated at from 7½ to 9 years. It would therefore appear that the water of this lake had some preservative effect. It was requested that an examination be made of the saline waters for preserving ties, and samples of water taken from lake Muskiki were forwarded to the laboratories.

From available analyses of the saline waters of these lakes it is observed that the principal salts present in the water of lake Manito are sodium chloride, magnesium sulphate, and potassium sulphate; the water of lake Muskiki contains magnesium sulphite, sodium sulphate, and a much smaller proportion of sodium chloride. None of these substances is very toxic, and under ordinary circumstances none could possibly compete with the wood preservatives in general use. However, it has been found that if a sufficiently high concentration of sodium chloride can be maintained in wood, decay will be inhibited, and the same is probably true for the other substances mentioned. The total amount of solids present in Muskiki water varies with the season of the year, being often as high as 30 per cent, so it seems possible that some cheap treatment such as soaking ties in this lake might be feasible.

The saline water examined had a specific gravity of 1·345, and small pieces of jack pine sapwood were impregnated with this saline solution at full strength and at various lower concentrations. These pieces, together with untreated pieces, were placed over mats of growing fungus (*Coniophora cerebella*) and after six months there was no noticeable fungus attack in those pieces treated with full-strength saline solution, slight signs of attack for lower concentrations, and considerable decay in the untreated controls. The fire-retardant properties of the Lake Muskiki brine will also be investigated.

Service tests of treated and untreated timber.—Practically every type of permanent or semi-permanent structure can be built with one or more materials, and, other things being equal, the construction material which provides the lowest annual cost is usually chosen. In order to calculate the annual cost, the useful service life of the material must be known. The purpose of this work is to obtain as exact data as possible on the actual service life of representative timber structures, and thus to facilitate the calculation of the annual charge of a timber structure with a fair degree of accuracy. The useful service life of wood varies; practically ever-lasting when kept continuously dry or continually submerged in fresh water, it may, on the other hand, last but a few years, when alternately wet and dry and thus subject to decay.

Marine borers and decay are the chief agents destructive to timber in service. Fortunately, marine borers are found only in sea water, but decay is found from the seacoast to the mountains.

In the utilization of timber in the various forms of engineering structures it is evident that conditions with respect to favouring or retarding decay will vary over a wide range. To this is added the variation in the natural durability of different species. Sapwood is less durable than heartwood, and heartwood timbers of the same species differ in durability by reason of rate of growth, resin content, and density. When timbers are cut in the spring of the year, temperature conditions are most favourable for fungus growth during the period when the high moisture content of the tree is being reduced to an air-seasoned condition. Timber can be infected and fungus growth established, although not discernible to inspectors. When the timber is seasoned, the fungus can remain dormant and resume rapid growth when placed in a structure under conditions where the timber can pick up moisture.

It is thus evident that a very large number of records are necessary on which to base estimates of the life of timber. Forms for recording data have been prepared and distributed to those responsible for the design and erection of timber structures, from which useful data on service life will be accumulated. The laboratories will act as a clearing house for collecting, tabulating, and distributing the information obtained.

Suitable forms for recording the service life of miscellaneous timber structures, telephone and telegraph poles, piling, fence-posts, and railway ties have been prepared. The distribution of the forms is meeting with a ready response, indicating that there is a real demand for more exact information on the service life of timbers.

Division of Timber Mechanics

Testing of small clear specimens.—Testing of air-dry specimens of white ash was completed. This species, together with beech and Eastern cedar, constituted a consignment of woods from Lower Hainesville, New Brunswick, which have been air-seasoning at the laboratories for the past two years.

The results of tests upon the green specimens of the above shipments and shipments of paper birch, black spruce, white spruce, jack pine, aspen poplar, and balsam poplar from Saskatchewan were incorporated in laboratory records of mechanical and physical properties of Canadian woods and made available to inquirers for such data.

Glues and gluing.—Tests upon 21 standard samples of animal glue have been carried out for the purpose of determining the relationships between their viscosity, jelly strength, absorption power, solution strength, and joint strength in shear.

The data obtained indicate that as the solution strength is increased the viscosity increases, but not in direct proportion. Each grade of glue likewise produces a different parabolic curve. As the strength of the solution is increased the jelly strength and the joint strength are also increased, but likewise not in direct proportion; the curve based on viscosity and strength of solution for any glue does not coincide with the curve based on jelly strength and strength of solution for the same glue. The absorptive power of the 21 samples was determined, but the analysis of the relationships with the other factors has not been completed.

Shear tests on glued joints of white pine and hard maple were made for the 21 samples in solution strengths of 2·5 per cent to 25 per cent in increments of 2·5 per cent.

A total of 2,808 tests was made under this project.

In addition 1,669 tests were made on samples of animal, casein, vegetable, and liquid glues submitted by commercial firms. Information was given on the use of the hot press for gluing, synthetic resin glues, glues for manufacture of plywood, and other topics.

Nail-holding power of wood.—Tests were completed on the holding power of 1¼-inch, 1½-inch, 1¾-inch, 2-inch, 2¼-inch, 2½-inch and 3-inch bright-box, cement-coated, and bright-common nails when driven into species of lumber commonly used in container construction, including balsam fir, white spruce, jack, red, and white pines, Eastern hemlock, basswood, yellow birch, and white elm.

The analyses were practically completed and indicate a definite relation between the specific gravity, the area of nail surface in contact with the wood,

and the holding power of the nail. It was also determined that the cement-coated nails have from 1½ to 3 times the holding power of bright nails, the greatest increase occurring when driven into softwoods and the least increase when driven into hardwoods.

A total of 1,930 tests was made during the year.

Shipping Containers.—Many investigations of the design and strength of containers were undertaken, including: wirebound crates for export of eggs, fibre-board containers for shipment of dynamite, wooden boxes for shipment of soft drinks, wooden boxes for export of medical supplies to India, and wooden barrels for export of apples.

A 7-foot box-testing drum was installed for testing smaller containers.

In connection with tests on fibre-board containers for shipment of dynamite it was necessary to construct a humidity chamber to maintain conditions of 90 per cent relative humidity at 75° F. The containers were subjected to these conditions over a period of two weeks prior to tests.

Structural timbers.—During the year the determination of the static-bending strength of small clear specimens cut from 550 joists—2 inches by 10 inches by 16 feet in dimensions—was completed. Rate-of-growth determinations were made on 1,260 end-sections of the full-sized joists. Analyses were made as to the effect of the various defects on the strength of the joists. By means of detailed sketches of the joists showing the class, size, and position of defects, various gradings were applied to the joists to determine the value of these gradings for classifying joists on the basis of strength.

The strength of the "mineral-stained" and the white wood of hard maple.—The analysis of tests previously carried out on green material was completed, and tests were conducted upon the kiln-dried material. This material included specimens of three descriptions, namely, (1) all white wood, (2) all mineral-stained wood, (3) both white and mineral-stained wood.

The specimens of (1) and (2) were tested to determine their strength values as compared with similar values for normal hard maple obtained from previous tests. These tests included static and impact bending, shear, cleavage, tension, and hardness.

The specimens of (3) were tested in shear and tension to determine whether a plane of weakness exists at the junction of the mineral-stained and the white material. While there was quite a difference in density and shrinkage values between the mineral-stained and the white wood, there was apparently no strength reduction in the plane at the junction of the two classes of wood. Both the mineral-stained and the white wood had strength values which corresponded closely to those for normal hard maple of similar density.

Miscellaneous testing.—Tests for a company manufacturing motor cars, on samples of hard maple showing indication of fungus attack, to determine if any loss of strength had taken place.

Tests on railway shims of heartwood of white birch rejected by one of the railways. The results indicated that white birch heartwood is just as suitable for use as railway shims as is the sapwood.

Tests for a chair manufacturer on the relative strength of several glues for the manufacture of chair-seats.

Tests for the Royal Canadian Air Force on woods used in air-craft construction.

Tests for the Department of National Defence on woods used in manufacture of felloes, spokes, and poles for general service wagons and gun limbers.

Tests for a newsprint company on cores for newsprint rolls.

Tests on glues and glued joints for 15 glue- and furniture-manufacturing companies.

Tests on wooden, corrugated, and fibre-board containers for 15 Canadian manufacturers.

A total of 12,251 mechanical tests was carried out during the year.

Division of Lumber Seasoning

Kiln-drying studies.—During the first month of the year the use of an outside kiln had to be secured owing to lack of kiln accommodation at the Laboratories. The expense was borne by the Department of National Defence, for which the investigation was being conducted. A new laboratory kiln was constructed during the year which is capable of drying material 8 feet 6 inches in length. It is of the external-blower type and of an original design of the Laboratories.

Arrangements were made for the construction next year of a new unit to be built in conjunction with the kiln built this year. The two units will be capable of use separately or jointly, thereby making provision for the drying of 4-foot, 8-foot, and 12-foot lengths of material.

Equilibrium moisture content studies.—Weighings were made of sample boards in commercial piles in Ottawa yards, and the moisture contents were studied in conjunction with meteorological data for the year. All figures for the district previously collected show that the equilibrium moisture content of lumber may be expected to reach a minimum in May, followed by an increase in June and July, and a second minimum in August. This year the moisture content continued to drop slightly in June, remained more or less stationary in July, and increased in August. The subsequent increase lagged behind the normal until November and December, when sharp increases were apparent, particularly in the pieces towards the top of the piles.

Air-seasoning studies.—Some work was done in all four subdivisions of this project, but owing to the great reduction in manufacture and the small movement in sales, the study was greatly restricted.

(*a*) Drying-rate studies.—Routine weighings and computations were made of the sample boards in test piles.

(*b*) Degrade studies.—A check on the down-tally of stock in test piles from a yard was made. No check on stock in three other yards in other centres was possible owing to lack of sales of stock from test piles in these yards.

(*c*) Cost studies.—The Canadian Lumbermen's Association co-operated with the division in securing further replies to the questionnaire sent out to individual firms last year. The data received were summarized, and a report is in preparation.

(*d*) Yard brown-stain studies.—Owing to conditions in the industry, it was possible to examine only one of the 26 commercial piles set aside for study when being run through the planing mill. Two experimental charges were run at the laboratory, and no evidence found to support the theory that sawdust-covered material is more susceptible, and water-soaked material less susceptible, to stain than ordinary stock.

The use of yellow birch and hard maple for spokes and felloes of artillery wheels.—Experimental material was purchased by the Department of National Defence, kiln-dried by this division, and rough-shaped into spokes and felloes in a local wood-working plant. These were divided into two lots; one was finished in the natural state, and the other was impregnated with zinc chloride, kiln-dried a second time, and then manufactured into wheels.

A close inspection was made throughout the various stages, and a report submitted on the kiln-drying, impregnation treatment, and fabrication processes.

A procedure was laid down (also in conjunction with the Department of National Defence) for observation during the service trials to which the finished wheels are being submitted.

The drying of maple last-blocks.—Two experimental charges were dried in the laboratory kiln.

A considerable amount of information regarding requirements of the United Kingdom market was obtained by investigation, and through correspondence with the Director of the Commercial Intelligence Service of the Department of Trade and Commerce and the Canadian Trade Commissioner at Bristol, England.

Wood-taint in butter boxes.—This investigation, which commenced last year, in co-operation with the Dairy Branch of the Department of Agriculture, to ascertain whether moisture content was a factor in the development of the highly objectionable "wood-taint" in butter stored in wooden boxes of certain species was continued. The tests did not disclose any data to justify the contention that moisture content was a factor in the development of taint. Observations were made during the tests, however, as to the equilibrium moisture content obtained, and these indicated that the air-dry condition was the most practicable.

Prevention of mould on cheese boxes.—This investigation was suggested as a result of the study of casein-formaldehyde treatment of butter boxes. Over 1,000 cheese boxes were furnished to the Laboratories by a large milk company and sprayed with the solution. The boxes were later filled with cheese by the company and put into commercial test. The results were reported to be very satisfactory.

Examination of sample last-blocks.—This examination was made at the request of the Commercial Intelligence Service of the Department of Trade and Commerce as a result of dissatisfaction with a shipment of Canadian blocks to England. A very careful examination was made and an exhaustive report prepared, which met with favourable comment from the Department of Trade and Commerce and the shoe-last trade. It was requested that certain sections of the report be issued to the trade for guidance in connection with last-block manufacture for the British market.

Kiln-drying of white birch.—Preliminary tests were made with a view to preventing the darkening of the colour of white birch in kiln-drying. Indications are that high humidities have a darkening tendency.

Twisting of laminated skis.—The assistance of the division was sought in the matter of overcoming the twisting which developed in laminated skis after manufacture. This investigation is still in progress, but indications are that the defect is due to a combination of reasons, among which are moisture content, manufacturing methods, and choice of material.

Division of Timber Physics

Wood Sections.—The collection of microscopic sections of the timbers of the world has been increased by the addition of sixteen species.

Porosity of wood.—An apparatus was constructed for testing the penetration by fluids of small samples of wood under controlled pressure.

It has been shown by test runs with various species in this apparatus that the rate of flow of water along the grain of small samples (arranged with one free end from which the liquid is collected) decreases, with time, from a relatively high initial rate to a low constant rate, although the pressure forcing the flow

is kept constant. The continued flow of water under pressure along the grain has the effect of building up in the interior of the wet wood a pressure that opposes the passage of the water along even the freely open natural channels of the wood. This decrease in the rate of flow of water through the small test-specimens is very similar to the decrease in the rate of absorption of preservatives by material of timber size in pressure treatments.

Measurement of the forced flow of liquids in small test samples indicates the relative adaptability of woods to preservative treatments and is, therefore, of value in appraising the wood's treating properties and in studying causes of uneven penetration of preservatives in different pieces of the same species or even of different parts of a piece.

Heat value of wood.—In view of the general interest in wood fuel, tests were undertaken to determine the efficiency of wood burned in domestic heating installations designed for coal.

At a meeting of representatives of the Forest Service and the Fuel Research Laboratories, arrangements were made for the Fuel Research Laboratories to conduct tests on some common wood fuels in their domestic hot-water heating apparatus. The Forest Products Laboratories undertook to supply the material and the necessary data regarding cubic contents, moisture content, and other points before delivering it to the Fuel Laboratories.

Seven fuel tests, of 120 hours' duration each, were made on split sugar-maple cordwood, both air-dry and partly seasoned, and on white pine edgings and slabs, both green and air-dry. The wood was burned in about 1-foot lengths with the following different arrangements of the grate: (1) on ordinary coal grate, (2) with perforated iron plate on the coal grate, (3) with coal grates removed and fire placed on fire-brick laid on the ash-pit floor.

The most efficient operation was secured with wood burned on the perforated plate only, a slight, but definite, improvement over tests with ordinary coal grates being noted. The Fuel Laboratories calculated the efficiency of the wood fuel from calorific determinations of it as burned. The ratio for given amounts of fuel between heat delivered to the boiler water and the gross heat value determined the efficiency.

Air-dry hard maple proved the most efficient fuel, delivering almost 60 per cent of its gross heat value to the boiling water as compared with about 50 per cent for dry pine slabs. On this basis, from 1 to 1·2 cords of the heavy hardwoods, which are the best fuels, should give a heating effect equivalent to 2,000 pounds of American anthracite coal of good grade. The heat value of the lighter woods is considerably less, since the fuel value of wood depends on the weight of combustible material per unit of volume.

A report based on these tests, showing the value of the various wood fuels as compared with coal, was prepared, and demands soon exhausted the first issue, requiring a second supply.

Streaky effect of stains on hardwoods.—Complaints regarding the streaky appearance of stains on hardwood were investigated, and it was noted that the so-called streaks were due to application of stains to wood characterized by undulating grain. In the areas where the undulations caused the pores to incline at sharp angles from the planed surface of the wood, the open pores imbibed the stain readily so as to give the wood a considerably darker appearance than the intervening regions, where the pores ran parallel with the surface and hence did not allow deep penetration of the stain.

The solution of the difficulty lies in the use of proper stains and fillers for wood with undulating grain.

Streaky effect in finished softwoods.—Complaints regarding the appearance of streaks when stains were applied in finishing softwoods were found due to exudations of oleo-resin. This defect may easily be prevented by kiln-drying

woods that contain oleo-resin so that the pitchy materials are brought to the surface, where they harden and may be removed by planing before the wood is put to use. Except for material which is exceptionally pitchy (and therefore should not be used for critical purposes) trouble from fluid oleo-resin may be avoided by adequate drying.

Pulpwood material.—Reports on quality of pulpwood samples, the proportion of various species in pulpwood shipments, the tension failures of fibres in pulpwood species with reference to the grinding process, and other topics have been made during the year.

General.—In addition to the various items previously mentioned, requests for information have been dealt with during the year on identification of wood samples; wood bending; insulating effect of wood, sawdust, and excelsior; quality of timber in handles, musical instruments and other specialties; quality of pulpwood; specific timber defects and other subjects.

Division of Timber Pathology

Reference collection of pathological material.—During the year specimens of three wood-destroying fungi were added to the collection, making a total of 891 specimens now on hand for reference. Cultures retained for reference were transferred twice during the year. Cultures to the number of eleven were added to the stock series, which now contains 150 cultures made from sporophore tissue or from spores.

Red stain in jack pine: its development in creosoted and untreated railway ties under service conditions.—Sixty experimental ties (40 untreated and 20 creosoted) were removed from track and analysed. Each tie was cut into eight 1-foot lengths, which were split in order to expose any stain or rot contained. The sections were then split in any plane in which the exposed transverse face suggested the presence of different types or degrees of rot. Cultures to the number of 5,716 were made from the ties, in order to trace the distribution of red-staining fungi and secondary wood-destroyers.

Following is a summary of the results obtained:—

(1) Although *Trametes Pini* was alive in jack pine ties after four years' service, it had died out in extensive areas, in each of which firm wood had been present, which might have furnished food for its development, but which in many cases had been destroyed by secondary wood-destroying fungi.

(2) Fungus No. 2 proved slightly more viable than *Trametes Pini,* but culture records indicate that its activity had been somewhat reduced.

(3) Thirty-one wood-destroying fungi, which had entered as secondary infections, were isolated from experimental ties after four years' service—thirty from untreated ties and two from creosoted ties. Of these, four (*Lenzites saepiaria, Lenzites trabea, Lentinus lepideus,* and *Fomes roseus*) were identified.

(4) *Lenzites saepiaria* was the most active destroyer of the jack pine ties analysed.

(5) In the course of four years under service conditions the sapwood of untreated jack pine ties was almost completely destroyed. Disintegration had advanced to such a degree that much of the sapwood fell away as the ties were handled. The heartwood also of many ties showed extensive decay, often in an advanced stage.

(6) Creosote introduced by the process applied in these tests preserved the ties to a marked extent. The sapwood of the entire twenty ties under study was firm and sound. In the heartwood of three ties secondary wood-destroyers were found; decay in two had spread longitudinally for a distance of from two to three feet; in the third tie decay was limited to a small central pocket of rot.

The investigation is still in progress, and ties will be analysed at intervals until the full number has been removed from track. Since decay of the untreated ties due to the attack of saprophytic fungi is proving rapid, a group of these ties will be removed every year until the supply is exhausted; in the case of the treated ties, removals will be made at two-year intervals.

It may be concluded, however, that ties containing red stain or red rot in amount insufficient to cause undue weakening of the timber at the outset should be accepted for service without anxiety as to the further development of the red-stain disease, since in seven years *Trametes Pini* made no appreciable advance in the red-stained ties under study.

Decay of pulpwood in block-piles.—Three samples of pulpwood, each of some fifty 4-foot sticks, were supplied by a paper company for determination of the percentage decay in each. The samples represent wood of 1927-28, 1929-30, and 1932-33 storage.

A beginning was made in the analysis of this wood, in order to determine as closely as practicable the deterioration from a pulping standpoint which occurs in pulpwood stored in block piles for different periods.

General.—Special problems receiving attention as the result of inquiries from wood-using industries included the following: (1) blue stain in white pine, and methods of preventing its development; (2) stain or decay in pulpwood, spotting of pulp, and slime trouble; (3) decayed flooring; (4) moulded mine timbers; (5) decay in automobile roofs; (6) prevention of decay in ammunition boxes, and (7) decay in buildings. Samples submitted with two requests contained decay of the true "dry-rot" type caused by *Merulius lacrymans.*

Division of Markets and Exhibits

Markets.—As a result of numerous inquiries as to the suitability of certain Canadian woods for tight-cooperage purposes, particularly regarding the possible use of birch for beer barrels, an investigation was carried out with a view to obtaining first-hand information from breweries, wineries, and cooperage plants, on the use of birch, Douglas fir, and other Canadian woods as barrel and tank stock. This work entailed the visiting of 32 plants in Ontario, which afforded information of considerable value not hitherto available to the Laboratories.

In an effort to further the use of Western red cedar in the United Kingdom, data were obtained from 26 tanneries, 36 pulp and paper plants, and 2 smelters in Canada, relative to their experience in the use of this wood under the very severe conditions obtaining in these industries.

The use of Douglas fir vats and tanks in Canadian breweries was the subject of a short investigation made at the request of a United Kingdom inquirer interested in the use of Douglas fir in Great Britain for such purposes. Information available through visiting breweries and wineries in Ontario was supplemented by that obtained through visiting breweries in Montreal, where Douglas fir beer tanks have been in use for some years. The data forwarded to the United Kingdom as a result of this inquiry was very favourable to the use of Douglas fir in these structures, and it is hoped will influence its use there in beer tanks, which require the very highest and most costly grade of lumber in fairly large quantities.

The laboratories' collection of foreign-made boxes used particularly in Empire countries was examined by several box-shook manufacturers, and in some cases sample boxes were loaned to some of these manufacturers. It is of interest to note that satisfactory new box-shook business of fairly large volume has been obtained, largely through co-operation of the Commercial Intelligence

Service and the Laboratories in supplying manufacturers with the necessary commercial and technical data to permit them to manufacture an article which could compete with foreign manufacturers.

Exhibits.—During the year there were distributed on request 195 sets of wood samples, 109 in Canada, 81 in the United Kingdom, 2 each in the United States and South Africa, and 1 in Argentina. These samples were prepared in sets of thirty small specimens, principally for schools; in sets of 15 panels 1 inch by 8 inches by 15 inches, labelled with the principal characteristics and uses of each wood for museums and dealers abroad; and in sets of 12 pieces, 1 inch by 3 inches by 6 inches, with concise descriptive labels of the properties and uses of each wood, for architects and architectural schools in the United Kingdom. These latter sets are contained in wooden boxes, and 62 such sets have been prepared and forwarded to date, at the request of Canadian Trade Commissioners.

There were also received during the year fifteen requests for miscellaneous exhibit material. These requests came from provincial governments, railways, the Canadian Government Exhibition Commission, manufacturers, and others.

Exhibitions.—The laboratories prepared and set up an exhibit of Canadian forest products for the Central Canada Exhibition held at Ottawa. Through the Canadian Government Exhibition Commission three exhibits—lumber, lumber products, and pulp and paper—were prepared for the Chicago Exhibition by the laboratories. Through this commission, also, an exhibit prepared by the laboratories was shown at the Foreign Relations Exhibition held in Montreal.

Considerable material was loaned to the Quebec Forest Products Commission for an exhibit prepared for the Produced-in-Canada Exhibition held in Montreal, and to the Forestry Branch of the British Columbia Department of Lands, for use on the Pacific Coast.

Division of Wood Chemistry

Work in wood chemistry was largely connected with the assembly of data and the preparation of reports, as the result of requests, on the following subjects: The production of gas for power from wood and charcoal, the production of sugar and alcohol from wood, the finishing of wood, the metallization of wood, the production of oleo-resins from Canadian woods, and the briquetting of wood and charcoal.

General

Publications.—During the year 7,644 copies of publications were distributed from the Ottawa Laboratories through their mailing list and 4,759 were sent out on special request.

The work of the Laboratories was reported in Forest Service publications, in mimeographed reports, in addresses before technical and trade organizations, and as reports in technical and trade journals.

In addition to the printed reports published by the Forest Service, a report entitled "Canadian Export Timbers" was prepared by these laboratories and published by the Commercial Intelligence Service of the Department of Trade and Commerce. The following mimeographed reports were also issued: Lumber Piling in Northern Climates, by W. J. LeClair; Softwood Distillation, by J. F. Harkom and M. J. Colleary; Heating Value of Wood Fuels (in French and English), by J. D. Hale; Life of Creosoted Wooden Piling when used for Building Foundations to Support Masonry Footings, by J. F. Harkom.

PULP AND PAPER LABORATORY (MONTREAL)

This division has maintained close co-operation with the pulp and paper industry through the executive officers of the Canadian Pulp and Paper Association and committees of the Technical Section of that association. With the ever-growing demand for technical efficiency throughout the industry, an increasing interest in the work carried out at the laboratories has been manifested. This has resulted in a clear understanding on the part of technical men in the industry of the type of work which the laboratories are best fitted to pursue. The discovery of useful fundamental data by the division's staff has been noted by men in the industry, and on that account the work of the laboratories has called forth very favourable comment at the general meetings of the association.

During the year under review the activities of the laboratory have included the study of methods of analysis and testing; fundamental researches into the properties of lignin, cellulose, pulp fibres, and wood; the study of chemical and mechanical wood-pulping processes; the standardization and calibration of pulp and paper testing equipment and accessories; the testing and analysis of woods, pulps, and papers submitted by commercial firms and individuals; the answering of technical inquiries; and the giving of information on subjects related to the manufacture of pulp and paper to the general public.

The following is a detailed description of these activities:—

Methods of Analysis and Testing

The study of methods of analysis and testing was confined to one major project, namely, the classification of pulps by selective screening. This study was commenced as a result of the necessity of finding some method for the examination of pulps in regard to their fibre classes. The evolution of an apparatus for fibre fractionation has continued. The final design is now ready for adoption as a standard instrument by the pulp and paper industry. This instrument has been in use for some months at the laboratories and has given excellent results.

The separation of pulp fibres into classes according to size has been a difficult task. The separation can be attempted only with a suspension of the pulp in water. In such a suspension the fibres have no definite orientation. Pulps differ greatly as to the type of fibre, fibre particle, or fibre bundle present. Chemical pulps are made up principally of long thin fibres or portions of such fibres. Mechanical pulps (ground-wood pulps) have particles which range from bundles containing a number of fibres or parts of fibres to fine fibre dust or flour. There are two types of fibre classification which are of interest. The first of these is practised commercially, and consists in separating the shives or fibre bundles from the single fibres and small fibre particles which are used in paper-making. The second type of classification has not been practised to any great extent commercially, but is useful as a means of analysing the pulp and thereby gauging its paper-making qualities. It consists in effecting a separation according to the longest dimension of the fibre or fibre particles. It is this second type of classification which is involved in the apparatus developed at the laboratories.

The investigations which have been carried out have led to the development of certain principles of screening which may some day be applied to commercial practice. So far, this aspect has not been given any extensive study. The mechanism of separation on the small scale alone has been examined, without reference to its application to the larger-scale operation. The object has been to effect a separation within very narrow limits of fibre size, to effect

this separation with great accuracy, and therefore in a manner which will allow of exact duplication. This objective has been achieved, and a design of apparatus has been adopted for manufacture according to exact specifications. This means manufacture as a standardized instrument.

Relation between tensile and bursting strengths of papers.—As a minor investigation, a short study of the relation between the tensile and bursting strengths of papers was carried out. Some years ago the United States Bureau of Standards developed a mathematical formula which stated this relation for machine-made papers. When, however, an attempt was made to utilize this formula on the test results of handmade sheets (sheets formed on sheet moulds used in the testing laboratory) it was found that the formula did not apply.

A study of the theoretical considerations in the rupture of sheets in the tensile and bursting testers showed that the relation as given should not hold. It was also concluded that present knowledge of sheet properties, the stresses set up in the test sheet during its preparation, and its testing in the machine causing rupture is not sufficient to allow of the development of any reasonable relation between bursting strength and tensile strength as recorded in the testing machines used. Further study was therefore abandoned after a preliminary investigation had shown the general direction and cause of failure in the tensile tester.

Lignified and delignified fibres.—The study of the bonding and other physical properties of lignified and delignified fibres has been continued. Previous study of cellulose-water relationships carried out on delignified fibre showed the necessity for a more extended study of cellulose-liquid relationships. This has been carried out, and the cellulose-alcohol relationships have been examined. The findings of this investigation have been of value in interpreting the results obtained in earlier work, and have provided the accurate data required to depict the reactions of the inner, or micellar, surface of the cellulose fibre when this is brought in contact with liquids.

The study has necessitated the use of a highly specialized technique and delicate apparatus. The successful conclusion of these experiments is especially gratifying, since a slight accident to the apparatus at any time would have meant the recommencing of a great deal of the work and would thereby have retarded the investigation considerably. A full report covering these studies is in preparation.

The bonding of lignified fibres has been studied along very different lines. In this case not cellulose but lignin is the material which must be investigated. In wood, and hence in wood fibres, there is, aside from the cellulose, a separate and distinct material with bonding properties; this material is called lignin. The study of lignin has been undertaken with a view to determining its bonding and other properties.

Lignin.—Lignin is of colloidal proportions and therefore its properties as a colloid have been investigated. It has been found to possess the characteristics of a gel. This gel may be made to undergo swelling, and this swelling may be reduced by an appropriate treatment. The pulping of wood is accompanied by either the disruption or the dispersal of the lignin, since this material acts as a cementing layer binding one fibre to another in the wood tissue; therefore, whether the pulping process be mechanical or chemical, the manner in which the lignin layer reacts in the process is of prime importance. In the mechanical pulping processes such as wood grinding, the force required to tear the fibre out of the wood tissue is greater or less, depending on the state of the intercellular bond. In grinding, friction causes a heating up of the water present between the wood and the grindstone. The high temperature reached causes a softening of the fibre bond and enables the grits or other cutting surfaces of the wheel

to remove the fibre from the wood. A fuller knowledge of wood softening will aid in estimating the forces and the type of forces required to produce mechanical pulp.

The study of wood softening was carried out on specially cut specimens. These were soaked in various aqueous solutions and the softening determined by means of deflection measurements. Marked softening was exhibited by the specimens in certain reagents. It was found that this softening was a reversible effect, since the washing out of the reagent caused a return of the wood to its normal rigidity.

A further study of the colloidal nature of lignin was undertaken, lignins prepared by different methods from wood being used. These lignins were purified by dialysis of the accompanying impurities through cellophane membranes. Pure lignin sols were obtained and used to determine flocculation values of the lignin. The data secured in this investigation have been useful in interpreting the mechanism of lignin removal in bleaching and chemical pulping.

Chemical Wood-Pulping

Chemical wood-pulping investigations were confined to the "kraft" process. Studies were pursued on both the laboratory scale and the semi-commercial scale. On the laboratory scale the mechanism of the pulping reaction was investigated. In this the part played in the kraft process by sodium sulphide was more particularly examined. By following the course of the reactions in regard to time—all other variables being kept constant—the rates of reaction of sodium sulphide solutions were determined. The mathematical treatment of the results has given a clearer idea of the reactions taking place and the degree to which these reactions are modified by an alteration in either temperature or cooking liquor.

The studies on the semi-commercial scale had as their objective the corroboration of findings in regard to digester operation obtained on a smaller scale. The success of these operations on the larger scale and the high qualities of the pulps obtained have shown quite clearly that within certain limits the results of the small scale can be interpreted very accurately in terms of the larger scale of operation.

Ground-Wood Studies

The mechanical wood-pulping process known as the ground-wood process was given intensive study during the latter half of the year. The variable most thoroughly examined was the speed of grindstone surface in relation to pulp quality, production rate, and power consumption. The data obtained in this investigation have shown the trend as regards the above factor in relation to stone speed. The commercial mills have taken note of the results, and certain of them have already made provision for a continuation of the experiments on a commercial scale.

Miscellaneous Services

Calibration of testing equipment has been carried out as usual. During the year 6 Canadian standard freeness testers and 109 parts were calibrated for use in the mills. A small number of British Standard Pulp Evaluation Apparatus and parts were also calibrated.

Testing of pulp, papers, etc., was carried out throughout the year. The total number of samples tested amounts to 376.

Technical inquiries relating to forest products and pulp and paper manufacture were received and answered to the number of 372.

General

Reports and publications were issued on all projects active during the year in the form of departmental reports, scientific publications, and in the Quarterly Review, the special medium through which progress at the laboratories is reported to technicians in the pulp and paper industry.

VANCOUVER LABORATORY

The year at the Vancouver laboratory has been one of great activity in various lines. Hundreds of requests for technical advice and assistance have been answered by the staff; several thousand copies of publications and reports, printed and mimeographed, have been distributed, and a number of addresses delivered by members of the staff before various scientific and trade organizations. A large number of visitors, particularly from England, Australia, and the Orient, have visited the laboratory.

Division of Timber Mechanics

The total number of mechanical and physical tests made by the division during the year was 16,885.

Standard tests for mechanical and physical properties.—Tests were completed on green material from one shipment of red alder, for which species no data had been available. Tests were made on several shipments of Sitka spruce in connection with a study of the relation of strength to variation in the number of growth-rings per inch. A preliminary report was written on a study of the effect of rate of growth (number of growth-rings per inch) upon the strength of Douglas fir.

Effect of variable moisture content upon the strength of wood.—Analysis of tests covering ten British Columbia species shows that there is practically no difference in bending and compression for each species tested when green and after six months' submersion.

Retention of nails and screws by wood.—Testing was continued under these projects to provide information on the holding power in wood of nails and screws under stress. Particular attention was paid to tests on the holding power of box nails.

Strength of glued joints.—As material was submitted by users of wood glues, investigations were made to determine strength, water resistance, and other properties of the glues. A considerable amount of work was done during the year on developing, from raw materials which were submitted to the laboratory, a formula for a casein glue which would be strong, water-resistant, and workable over a considerable period of time. Several firms producing plywood were given assistance in determining the cause of separation of plies, the water-resistance of the glue used, and in suggesting changes in manufacturing procedure and glue formulae.

Tests of structural timbers.—Investigations are in progress to obtain information regarding the strength of British Columbia timbers in structural sizes. Tests were carried out on Western hemlock joists 2 inches by 10 inches by 16 feet in the green condition and on Douglas fir 6 inches by 12 inches by 16 feet in the air-dry condition. Mimeographed copies of the test results were distributed upon direct request of many interested parties.

Matched pieces of Western hemlock were obtained for testing, after air-seasoning, to provide information on the effect of air-seasoning upon strength.

Exact records have been kept for each piece tested, showing for all four faces the location, size, and nature of all defects, so that any individual piece can be graded with exactness according to any grading rule in force.

In this connection, the British Columbia Lumber and Shingle Manufacturers, Limited, were supplied with a great deal of information for use in their Trade Extension Program in Great Britain and were given assistance in formulating a new set of grading rules, which are to be called Astexo Grades UKAY "A" List. These are now practically ready for printing.

Tests were also made on Douglas fir timbers taken from an old house built near Victoria about 1870, with the object of adding to the general knowledge with regard to the effect of age upon timbers in service.

Pole investigations.—A final report was published on the tests of lodgepole pine telephone poles, both untreated and treated, which will supply a long-felt need for information regarding this species. Tests were completed on creosoted Douglas fir poles, and all results made ready for publication. Information covering the results of such tests has been supplied to the telephone departments of the Prairie Provinces.

Investigation of the retention of railway spikes by untreated and treated Western hemlock ties.—This investigation was undertaken at the request of creosoting companies, who supplied all material, to determine the force required to withdraw railway spikes from untreated and treated Western hemlock. It was later enlarged to include the strength of hemlock in tie size under compression perpendicular to the grain. All tests were completed. Little or no knowledge was previously available, and, as an appreciable number of Western hemlock ties have been treated for service, this information is essential to an increased use of Western hemlock for this purpose.

Miscellaneous tests on wood.—From time to time specific problems arise in the use of wood, having regard to its suitability for certain purposes, and commercial and industrial firms avail themselves of the services of the Laboratory to secure definite data on the strength and other properties of their products. Two shipments of Sitka spruce for the Australian Air Board were inspected, and tested when necessary, and tests of lesser importance were made for other inquirers. Tests have been made for the Department of National Defence in order to determine the suitability of Sitka spruce for use in aeroplane construction and repair.

Custom Tests.—Because of lack of other large testing equipment in British Columbia, the testing machines of the laboratory are available upon sufficient advance notice for tests of construction materials on payment of the prescribed fee.

Tests were made during the year on such diversified materials as flax gilling twine, hemp and sisal rope, wire rope, reinforcing bars, shafting, heat-treated aluminium, and boiler plate.

Division of Timber Products

Lumber seasoning.—Studies on the absorption of moisture by seasoned lumber were carried out along two different lines.

The investigation of the change in moisture content of seasoned lumber when shipped by water under different stowage conditions to various world ports was continued, and a report prepared covering thirty-three such shipments. The results show that the gain in moisture content of seasoned lumber, properly stowed, while *en route* from British Columbia to the United Kingdom, Australia, South Africa, Trinidad, and Eastern Canada (via the Panama canal) is low. Seasoned lumber loaded in British Columbia at the correct moisture

content and properly stowed for shipment to the main lumber-importing ports of the world will arrive at its destination at a satisfactory moisture content.

A study of the equilibrium moisture content of lumber in various lumber-producing districts in the interior and northern coast forest regions of British Columbia was continued, weekly determinations of moisture content being made in six districts through the co-operation of selected weather observers and lumbermen. Similar studies of equilibrium moisture content conditions in the vicinity of Vancouver were also made by hygroscope readings at the laboratory and test weighings at a sawmill in the vicinity of False Creek.

A number of studies in connection with the air-seasoning of lumber were made. By means of these studies, the various factors affecting air-drying are studied, and the results applied in improving air-seasoning practice. Studies undertaken during the year included:—

(a) *Influence of thickness of crosser on the drying of 2-inch Douglas fir.*—This study was initiated to determine the feasibility of reducing end and surface checking in air-seasoning wide Douglas fir Clears by the use of 1-inch crossers instead of the customary 2-inch crossers. The results obtained, while not yet complete, indicate that the use of 1-inch crossers may result in an appreciable decrease in degrade without materially increasing the drying time.

(b) *Influence of board spacing on the drying of 1-inch Douglas fir.*—This study was initiated to determine the effect of three methods of board spacing on the drying of 1-inch lumber. The results obtained to date indicate that the rate of drying lumber, piled with 1½-inch spaces between the boards in each course and no circulation flues, is more rapid than in piles where the space between boards is reduced and circulation flues from 8 to 12 inches wide used.

(c) *Air-seasoning of timbers and poles.*—In this study of the rate of drying of Douglas fir structural timbers and Western red cedar poles, the moisture distribution was tested electrically by means of electric leads inserted at different depths and connected to a moisture meter. The study was not completed.

(d) *Effect of surfacing on seasoning.*—In this study the relative rate of drying and the shrinkage of lumber when rough and when surfaced are determined. The work is still in progress.

(e) *Air-seasoning of lumber for special purposes.*—This included studies at various mills in connection with the seasoning of Douglas fir of different sizes to conform to the London County Council moisture-content specifications and also of a special order of aeroplane spruce for Australia. Test piles were also erected to obtain data on the feasibility of air-seasoning 2- and 3-inch Douglas fir during the winter months to conform to the different requirements of foreign purchasers. This collection of information required by the lumber industry in meeting new demands for its product is an important phase of the air-seasoning investigations.

Kiln-drying.—A very important function of the laboratory is research in kiln-drying British Columbia species of lumber, an experimental kiln being an essential part of the equipment. This kiln, which is of the internal-fan cross-circulation type, is equipped with variable speed motor for experimenting with different circulation speeds, and with complete automatic control of temperature and humidity, and also with meters for the measurement of steam and power consumption. Splendid co-operation has been obtained from the lumber industry, members of which supply free of charge the green lumber required for test runs in the experimental kiln. The drying schedules for the more important species and sizes of lumber which have been evolved from these experimental kiln-runs are now in general use in the industry.

Of special interest during the year is the study of the effect of circulation on the kiln-drying of Douglas fir. In each group of runs, the temperature, relative humidity, and drying times are uniform, the rate of circulation being the only variable. A record is kept of the rate and quality of the drying of the lumber and of the steam and power consumption. The results to date indicate that in 1-inch Douglas fir lumber an increase in the circulation rate beyond a certain point results in a marked increase in the steam and power consumption without a corresponding increase in drying rate.

Increasing demands for British Columbia lumber in foreign markets resulted in numerous requests for brief studies or consultation visits to sawmills and wood-working plants in connection with their seasoning problems. These special investigations included such commercial problems as kiln-drying 4-inch by 4-inch Douglas fir and Western hemlock for use as paper-roll ends; kiln-drying door stock and factory lumber for use in the manufacture of doors for the United Kingdom; kiln-drying of special sizes, such as 3-inch Douglas fir, and special items of lumber, such as alder and maple for furniture, and arbutus for pipes; seasoning and manufacture of box shooks to conform to different moisture-content and size specifications.

The effect of kiln-drying at different temperatures on the life of Western red cedar shingles was studied by means of periodical examinations of twenty-six test panels erected in 1929. This study is of special importance at the present time in view of the efforts being made to develop a world market for high-grade shingles.

A project to determine the effect of seasoning and dipping on insects injuring lumber was undertaken in co-operation with the Entomological Branch of the Department of Agriculture. A report on the effect of kiln temperatures and of air-seasoning on ambrosia insects (pinworms) has been published. The results of the dipping experiments conducted during the year were not satisfactory, and indicated that the use of kiln temperatures of 140° Fahrenheit and higher, for a two-hour period, is the most effective and practical method now known of destroying these insects in green 3-inch lumber.

Utilization.—The study of improved methods of utilizing sawmill waste was continued. The utilization of mill waste and sawdust for fuel is now an important and profitable phase of the lumber industry, resulting in certain cases in the mill refuse-burners being lighted for only a few hours daily. It is estimated that in Vancouver and district there are 5,500 sawdust-burner attachments to domestic furnaces, which, together with larger installations in theatres and other large buildings, result in the utilization of approximately 70,000 units of sawdust per annum of a value of about $250,000. The laboratory receives many requests for information on the heating value and storage of various forms of mill waste and on the profitable conversion of surplus edging to sawdust which is readily saleable.

Information was assembled on lumber prices and manufacturing costs for use in compiling the report on a milling study made at a local sawmill. Such study was made as a preliminary to the new series of studies to determine the effect of log size and grade on lumber manufacture.

Information was assembled on the use of power saws for felling and bucking, and the laboratory co-operated in a demonstration of various types of such saws.

The possibility was investigated of utilizing the fine sawdust resulting from the manufacture of seasoned lumber as a substitute for certain grades of imported wood-flour. Samples of fine sawdust, representing five British Columbia wood species, were collected and submitted to the Explosives Branch of the Canadian Industries, Limited, for a series of tests. The high resin content of

Douglas fir and the difficulty of obtaining a supply of Western hemlock sawdust at a guaranteed moisture content of 8 per cent are reported as being some of the difficulties that have to be overcome.

Timber Pathology.—Test shipments of lumber were made to Australia in continuation of the study of the occurrence, cause, and means of prevention of stain and decay in water shipments of lumber from British Columbia. So far, the study has indicated that although the amount of decay which occurs in transit is negligible, the occurrence of stain and discolouration in shipments of green lumber may be considerable.

Progress was made on an investigation of the effect of kiln-drying upon the sterilization of lumber. Under certain circumstances, decays present in standing timber may continue to develop after the lumber has been manufactured and placed in service. Test runs on Douglas fir containing various known decays were made in the experimental kiln to determine the lowest kiln temperatures which will kill the wood-decaying organisms present in infected wood. With one common rot in Douglas fir, a temperature of 140° Fahrenheit, combined with a relative humidity of 80 to 100 per cent, for six hours, was sufficient to sterilize 1-inch by 4-inch material.

Additions were made to the reference collection of mycological material. This collection contains cultures, in duplicate, of the chief wood-destroying fungi, sporophores of wood rots, and wood specimens in the incipient and typical stages of decay, as well as a large number of specimens containing unusual natural defects. This collection was in use in connection with the identification of the cause and significance of certain defects in wood specimens submitted for examination by various lumber organizations. In this connection the sap-staining fungus *Trichosporium tingens* Lagerberg and Melin, which has hitherto been unrecorded in British Columbia, was identified.

The study of the relative durability of British Columbia woods was continued, data being obtained from material in use under service conditions. A number of shingle roofs were also examined in connection with the study of factors affecting the durability of Western red cedar shingles, and a series of laboratory experiments made, at the request of certain shingle manufacturers, on the effectiveness of a certain shingle oil stain.

Inquiries for pathological assistance during the year included a number of cases where rot had attacked dwelling houses or industrial plants, usually through faulty construction. Methods of eradication and prevention were suggested in each case. The demand from the lumber industry for species identification of wood specimens increased considerably during the year.

Exhibits

Many calls were received for samples of British Columbia woods and also for assistance in the preparation of displays of forest products. Nineteen sets of hand samples of eighteen species were distributed and several sets, mounted in attractive yellow-cedar boxes, were specially prepared for forestry visitors to the Pacific Science Congress. Several individual samples, as well as many special samples to meet unusual conditions, were also sent to organizations in Canada, the United States, England, Australia, Hawaii, West Indies, China, and Japan. A few samples of Philippine and New Zealand woods and a special disk of lignum vitae were added to the laboratory collection

Information was supplied to the Forest Branch of the British Columbia Department of Lands relative to the collection, preparation, and display of a permanent exhibit of woods and wood products, both local and foreign, and loan was made of several exhibits required for special displays. A number of large

frames were made up of different British Columbia woods for the display of photographs of forestry subjects at the Regina Grain Fair. Assistance was also given to the British Columbia Lumber and Shingle Manufacturers, Limited, in the preparation and shipment of a supply of exhibit material to be used in a permanent marketing display in Shanghai. They were also aided in the layout and set-up of a small display at the Vancouver Exhibition in conjunction with the forestry exhibit prepared by the Canadian Forestry Association.

Minor Investigations

Among other matters receiving attention during the year may be noted the following:—

A preliminary study of the relative merits of yellow cedar and Port Orford cedar for battery separators was made and information assembled on this subject, all of which indicates that yellow cedar should prove satisfactory for this purpose, but that more exhaustive studies are desirable in order to establish the best treating methods.

The possibility of increasing the use of black cottonwood for match splints for the Oriental trade was investigated. Samples were collected from different areas for the comparison of colour range, and several sample logs were sent to manufacturers in China. A sample shipment of aspen was also arranged. As a result of these shipments, trial orders have been placed.

A small selection of madrona *(Arbutus Menziesii)* was cut up, seasoned, and forwarded to England for study as to its possible utilization for the manufacture of tobacco pipes.

An assembly of information was made of the properties of Sitka spruce which make it peculiarly suitable for diving boards.

A representative of the Laboratories sat with the committee of the British Columbia Lumber and Shingle Manufacturers dealing with the revision of the grading rules for British Columbia lumber entering the United Kingdom, and from the results of laboratory studies was able to give assistance in the final preparation of the new rules.

General

Besides printed publications, mentioned elsewhere, mimeographed reports were issued as follows:—Wooden scows: some factors affecting their durability, by H. W. Eades; Recommended schedules for the kiln-drying of certain species of British Columbia lumber, by J. H. Jenkins; Moisture in wood and its determination, by J. H. Jenkins; The kiln-drying of Douglas fir door-stock and factory lumber, by J. H. Jenkins; Cross-grain in lumber and its effect upon strength, by J. B. Alexander; Progress Report No. 4: Change in moisture content of dry lumber when shipped by water to various world ports, by J. H. Jenkins.

Publications

During the year the Forest Service has issued the following printed publications:—

Bulletins.—No. 85, The Forests of Manitoba; No. 86, Kiln-drying British Columbia Lumber. A revised edition of Bulletin No. 61, Native Trees of Canada, was also issued.

Circulars.—No. 38, The Effect of Kiln Temperatures and Air-seasoning on Ambrosia Beetles (Pinworms); No. 39, The Design of Wooden Boxes; No. 40, Open-tank Treatment of Red Pine Lumber; No. 41, Western Red Cedar: the Significance of its Heartwood Colorations; No. 42, The Strength of Lodgepole Pine Telephone Poles. Circular No. 23, Report on the Absorption of Moisture by Kiln-dried Lumber, was reprinted.

Miscellaneous.—Forest Facts, 1933.

Pacific Science Congress

In June, 1933, the Pacific Scenic Congress met in Victoria and Vancouver. Considerable prominence was given in its proceedings to the subject of forestry. Various members of the staff of the Forest Service contributed technical papers, dealing on the one hand with various phases of forestry proper, and on the other hand with research in forest products. These contributions were well received, and the contacts established are proving highly valuable in regard to the international aspects of the work of the Service.

British Empire Forestry Conference

The British Empire Forestry Conference which meets at five-year intervals was to have assembled in 1933 in South Africa. Owing to unfavourable economic conditions, however, it was decided by the Standing Committee on Empire Forestry to postpone the meeting until conditions improved. In order not to disturb the continuity in the work of the Conference, however, the usual quinquennial reports were prepared and forwarded. The great value of this Conference in maintaining forestry connections throughout the Empire was thoroughly demonstrated at the time of the Imperial Economic Conference held in Ottawa in 1923.

Other Conferences and Conventions

Although the funds available for participation in conventions and conferences were very limited, the Forest Service has during the year made every effort to maintain its contacts with similar organizations elsewhere, and also with various branches of the wood-using industry in Canada.

Conclusion

Confronted with many difficulties attendant upon the industrial upheaval of the past few years, the Service has found very great encouragement in the co-operation received from these various organizations, and has deep satisfaction in the knowledge that its efforts are more and more meeting with the appreciation of the great forest industry of this Dominion. The trying times through which all organizations having to do with forests are passing have done much to focus efforts on some of the fundamental weaknesses of past practices. So far as Canadian forestry in general is concerned it has suffered serious set-backs; but at least it may be said that if there is one fact that stands out vividly, it is that during the period of recovery, and in the more prosperous times to which recovery is unquestionably leading, the governments, the industry, and the people in general could, with propriety and great economic benefit, give greater heed to the protection, regeneration, and more provident use of the forest resources with which Canada is endowed.

In concluding this report, nothing is more fitting than that mention should be made of the passing, in February, 1933, of the late Lord Lovat. Not only was Lord Lovat an outstanding figure in forestry of the United Kingdom, but through his indefatigable work for the British Empire Forestry Conference, which he founded and of which he was Chairman for several years, he had brought his great influence to bear in forestry throughout the Empire. To Canada, he gave much, and to Canadians he had endeared himself. His actions were characterized by great courage; his messages teemed with candour. In a terse message and sincere warning to British people, the inferences of which are clear, he said:—

"It is an unfortunate fact, but one that it is necessary to mention, that while our race is the least interested of all nations in forestry science, we are of all nations the most active in the destruction of forest resources. Canadian sawmills, American logging organizations, New Zealand and Australian axemen are the last word in efficiency and despatch. Almost every devilish invention for the destruction of growing timber owes its conception to the Anglo-Saxon mind."