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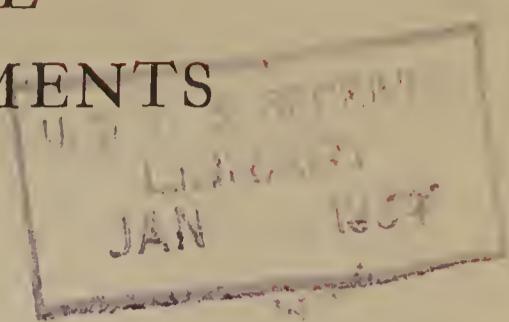
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OUR NATIONAL TIMBER REQUIREMENTS



FROM

"A NATIONAL PLAN FOR AMERICAN FORESTRY"

A Report Prepared by the Forest Service, U. S. Department of Agriculture
in Response to S. Res. 175 (72d Congress)

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OUR NATIONAL TIMBER REQUIREMENTS

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INTRODUCTION

The purpose of this analysis is to review past experience and to evaluate current trends in the consumption of wood and other important forest products in the United States, in order to throw as much light as possible on what the Nation's normal needs for such products, translated into terms of timber, may be in the future. The study therefore has to do only with effective demand for forest products as commodities of consumption, leaving to other discussions the needs of the Nation for forests for such purposes as regulation of stream flow, control of erosion, recreation, and fostering of wild life.

“Requirements” is not a wholly satisfactory term to define the extent of past, present, or future use of wood. Where timber is abundant and easily accessible, “requirements” inevitably absorb a far greater quantity of this cheap and adaptable raw material than would come into demand under other circumstances; competition from other materials is reduced; substitution moves rather in the opposite direction, and wood replaces other more costly and less readily accessible materials. On the other hand, where wood is scarce and hard to get, actual use is not a measure of what requirements might be under more favorable conditions. The community or region may not consciously demand more wood and may yet be at a disadvantage in a number of ways through lack of an abundant supply of wood at hand.

For want of a better term, however, “requirements” is used, not to denote irreducible needs, but as a measure of use by consumers afforded a reasonable latitude in choice of materials.

Consumption, while deficient in certain respects as a gage, is the only practical measure of past and current commodity requirements and is therefore accepted in this analysis with such allowances as judgment dictates. An absolute measure of requirements would necessarily be quite theoretical, and unreliable at best.

Since no one can say precisely what our timber requirements will be at any future time, this report does not attempt to do so. Sound policy making, however, must aim to anticipate requirements with some degree of probability, and this report is an attempt to supply

part of the needed data. Unfortunately the record of past experience is none too good, and the present investigation emphasizes the importance of better statistics of requirements and more systematic study of the factors affecting them.

COMMODITIES CLASSIFIED

The report is confined to the more important industrial products and to the use of wood for domestic fuel, omitting products which have only minor influence on the volume of demand. Lumber, which includes material for construction and for boxes, furniture, vehicles, railroad cars, woodenware, toys, and other factory products, represents by far the largest industrial consumption of timber, and is of the greatest present concern. Pulpwood comes next. While far below lumber in importance if gaged by quantity of timber consumed, it is of vast importance when measured by value of products and the part that pulp products play in our civilization. Railroad ties are important both as to quantity of timber consumed and service rendered. In naval stores (turpentine and rosin), the United States is the principal world producer, exporting almost twice as much as all other countries combined. These five classes of forest products—lumber, pulpwood, railroad ties, fuel wood, and naval stores—will be the principal subject of discussion.

The study is carried only through 1929 for most items, partly because data for later years are not complete, but more particularly because the present depression overshadows completely all other factors in commodity consumption since that year. The present low consumption, as a phase of the depression, is a general condition that does not in itself indicate a permanent change for one commodity any more than for another. For instance, the decline of 50 percent in lumber consumption from 1929 to 1931 should not be confused with the normal declining trend which will be shown to have prevailed since 1906. Other manufacturers have experienced abnormal declines since 1929, and there seems no reason for assuming that lumber products will not recover from the effects of the depression in proportion to the recovery of all other commodities.

LUMBER CONSUMPTION TRENDS

STATISTICAL

From 1809 to 1906 the trend of lumber consumption in the United States was constantly upward; since 1906 it has been downward, both per capita and in the aggregate. Consumption for the years 1809 to 1931 is shown in table 1 by balancing production, imports, exports, and changes in stocks. In figure 1 the total and per capita lumber consumption trends since 1899 are shown in relation to the trend for all manufactures and the population curve. Total lumber consumption declined from a maximum of approximately 45 billion board feet in 1906 to 34 billion in 1929. While there may be some question as to whether 1929 was a "normal" year in view of a generally recognized depression in agriculture, the collapse of the stock market, and other adverse factors, yet there is reason to believe, as explained later, that lumber consumption in that year was approximately of the expected normal proportions. The more precipitous drop since 1929 registers

the abnormal effect of the current general depression and cannot be interpreted as a change in the long-time trend. Per capita consumption climbed from 460 board feet in 1899 to a maximum of 525 board

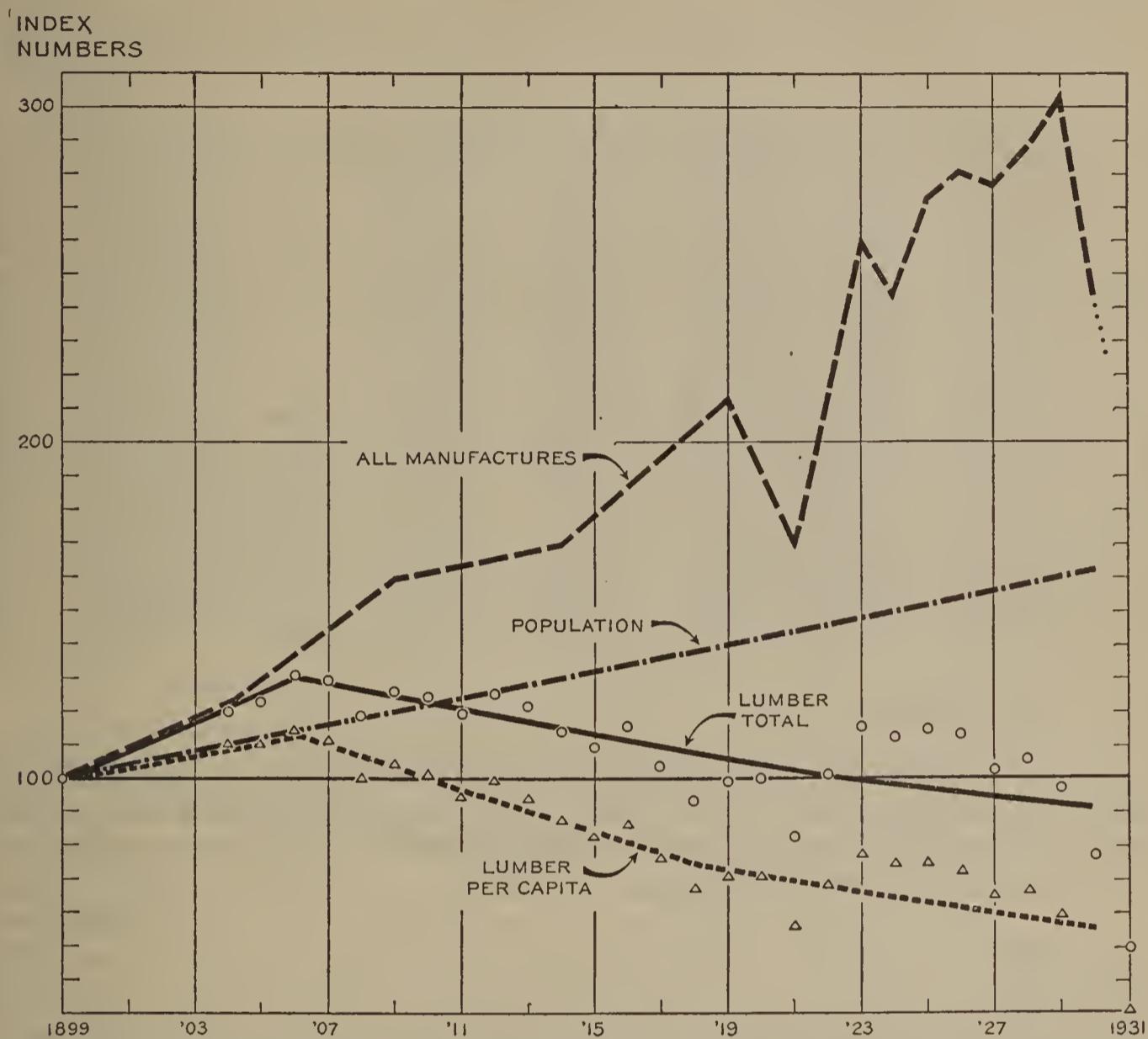


FIGURE 1.—Lumber consumption trends, compared with trends of all manufactures and population.

feet in 1906, and then declined to 275 feet in 1929. The figure reported for 1931 is only 130 board feet.

TABLE 1.—*Lumber production, exports and imports, and consumption, specified years, 1809–1931*

Year	Production			Exports	Imports	Changes in mill stocks	Visible consumption	Per capita consumption (rounded)
	Softwood	Hardwood	Total					
1809	<i>Mft. b.m.</i>	<i>Mft. b.m.</i>	<i>Mft. b.m.</i>	400,000			400,000	55
1819				550,000			550,000	55
1829				850,000			850,000	65
1839				1,604,000			1,604,000	95
1849				5,392,000			5,392,000	235
1859				8,029,000			8,029,000	260
1869				12,755,543	134,370	332,692	12,953,865	340
1879				18,091,356	275,102	355,304	18,171,558	365
1889				27,038,757	571,075	648,174	27,115,856	435
1899	26,371,336	8,706,259	35,077,595	1,004,464	423,928		34,497,059	460
1904	32,538,000	10,462,000	43,000,000	2,156,581	746,556		41,589,975	505
1905	32,960,000	10,540,000	43,500,000	2,012,049	938,001		42,425,952	505
1906	34,900,000	11,100,000	46,000,000	2,317,477	1,178,701		44,861,224	525
1907	34,946,000	11,054,000	46,000,000	2,501,486	1,056,965		44,555,479	510
1908	31,945,000	10,055,000	42,000,000	2,064,748	894,877		40,830,129	460
1909	33,896,959	10,612,802	44,509,761	2,293,242	1,083,018		43,299,537	475

TABLE 1.—*Lumber production, exports and imports, and consumption, specified years, 1809–1931—Continued*

Year	Production			Exports	Imports	Changes in mill stocks	Visible consumption	Per capita consumption (rounded)
	Softwood	Hardwood	Total					
1910	34,029,000	10,471,000	44,500,000	2,652,197	1,117,504	-----	42,965,307	465
1911	33,020,000	9,980,000	43,000,000	3,009,434	925,488	-----	40,916,054	435
1912	34,695,000	10,305,000	45,000,000	3,038,173	1,084,720	-----	43,046,547	455
1913	34,065,000	9,935,000	44,000,000	3,293,037	1,031,016	-----	41,719,979	430
1914	31,481,000	9,019,000	40,500,000	2,294,475	949,136	-----	39,154,661	400
1915	29,655,000	8,345,000	38,000,000	1,526,618	1,096,287	-----	37,569,669	380
1916	31,344,000	8,656,000	40,000,000	1,571,545	1,265,561	-----	39,694,016	395
1917	28,325,000	7,675,000	36,000,000	1,346,519	1,234,447	-----	35,887,928	350
1918	25,277,000	6,723,000	32,000,000	1,233,706	1,246,712	-----	32,013,006	310
1919	27,407,130	7,144,946	34,552,076	1,677,843	1,190,845	-----	34,065,078	325
1920	27,610,000	7,390,000	35,000,000	1,916,166	1,416,175	-----	34,500,009	325
1921	23,444,000	5,556,000	29,000,000	1,511,396	902,216	-----	28,390,820	260
1922	28,922,000	6,328,000	35,250,000	1,960,639	1,563,211	-----	34,852,572	315
1923	33,220,000	7,780,000	41,000,000	2,472,352	1,993,327	-798,000	39,722,975	355
1924	31,549,000	7,951,000	39,500,000	2,712,501	1,766,068	+247,000	38,800,562	345
1925	33,284,000	7,716,000	41,000,000	2,648,023	1,875,101	-774,000	39,453,078	345
1926	32,078,000	7,672,000	39,750,000	2,870,145	1,932,862	+391,000	39,203,717	335
1927	29,975,000	7,275,000	37,250,000	3,181,590	1,781,116	-425,000	35,424,526	300
1928	29,852,000	6,898,000	36,750,000	3,382,281	1,493,448	+1,718,000	36,579,167	305
1929	29,813,345	7,072,687	36,886,032	3,364,470	1,570,082	-1,411,000	33,680,644	275
1930	21,363,000	4,737,000	26,100,000	2,410,210	1,240,120	+757,058	25,686,968	210
1931	13,875,000	2,675,000	16,550,000	1,770,058	758,454	+658,692	16,197,088	130

Forest Service compilation.

In view of the minor fluctuations evident in figure 1, which fail to represent for any one or two years what may be termed the normal trend, per capita consumption can be expressed perhaps more soundly on the basis of 10-year averages, as follows:

	Feet board measure
1900 to 1909	495
1910 to 1919	395
1920 to 1929	315

Statistics do not show specifically the decline in lumber consumption in each field of use, but some break-down is necessary in an effort to find the reasons for the changes that have occurred. The best figures available for the purpose are given in table 2. The period 1912 to 1928 was chosen because statistical studies had been made of consumption in factory products and in sash, doors, and millwork for those years; the balance of total lumber consumed was assumed to have been used in construction. The years 1912 to 1928 cover in the main the period of declining consumption in which we are interested.

Factory products held practically the same relative position in the 1928 distribution as in that of 1912, and fell off only 8 percent in lumber consumed. The percentage of lumber estimated as going to construction in 1928 (72 percent) was only slightly less than that in 1912, but the actual difference of 5.6 billion feet is striking. When this total is analyzed, it is found that the direct-to-construction item accounts for all but 100 million feet of the loss in all lumber between the two years. The decline in direct-to-construction products might suggest a falling off in building were it not for the gain of 32 percent in sash, doors, and millwork, which can only be explained by an increase in building.

TABLE 2.—*Tentative distribution of national lumber consumption for 1912 and 1928*

Class of use	1912 consump- tion	Per- cent	1928 consump- tion	Per- cent	Gain (+) or loss (-)	Per- cent
	<i>Ft. b. m.</i>		<i>Ft. b. m.</i>		<i>Ft. b. m.</i>	
Factory-----	11,200,000,000	26	10,300,000,000	28	-900,000,000	-8
Construction:						
Sash, door, and millwork-----	2,500,000,000	6	3,300,000,000	9	+800,000,000	+32
Direct to construction-----	29,300,000,000	68	22,900,000,000	63	-6,400,000,000	-22
All lumber-----	43,000,000,000	100	36,500,000,000	100	-6,500,000,000	-15

As a matter of fact, the period from 1919 to 1929 witnessed a boom in construction. Not only did the building industry reach a peak, but both general industrial output and consumption of general goods were at a maximum. This would suggest that a lumber consumption for 1928, even larger than that of 1912, might have been expected. And if lumber use had merely followed general trends, the year 1928 would have seen a per capita consumption at least equal to that of 1912, and on that basis alone the total consumption would have been 54 billion board feet. But the fact of a 5.6 billion feet decline remains.

FACTORS AFFECTING TRENDS OF LUMBER USE IN CONSTRUCTION

Construction, particularly as regards the use of lumber, can be separated into rural and urban classes. Urban construction can be further divided into two distinct types—residential and nonresidential. Table 3 presents a tentative distribution of lumber consumption in these major fields of construction, as explained in the course of the discussion.

THE PASSING OF AGRICULTURAL EXPANSION

The farm is one of our greatest markets for lumber. The total number of farms in the United States has remained almost stationary in the neighborhood of 6½ million for the past two decades, whereas during the previous two decades the number increased at an average rate of 90 thousand annually.

TABLE 3.—*Tentative distribution of direct-to-construction lumber, 1912 and 1928*

Class of use	1912 consump- tion		1928 consump- tion		Gain (+) or loss (-)	
	<i>M. ft. b. m.</i>	<i>Per- cent</i>	<i>M. ft. b. m.</i>	<i>Per- cent</i>	<i>M. ft. b. m.</i>	<i>Per- cent</i>
Rural construction-----	15,000	51	5,500	24	-9,500	-63
Urban residential-----	9,000	31	12,000	52	+3,000	+33
Urban nonresidential-----	5,300	18	5,400	24	+100	+2
Total-----	29,300	100	22,900	100	-6,400	-22

In other words, by 1910 agriculture had passed the period of expansion so typical of our earlier history. Prior to 1910, if we assume 50,000 board feet as a reasonable estimate of the lumber required for the average farm fully equipped, there was a prospective market for 4½ billion feet of lumber annually for 90,000 new farms. Inasmuch as the process of equipping a farm usually extends over a number of years, the full loss of this market would not be felt immediately, but should show itself definitely within a decade or two after expansion had ceased.

It is true that since 1910 there has been a pronounced shifting of farm location, as illustrated for an intermediate 5-year period by figure 2. Abandonment in the eastern "general-farm" region has been concomitant with acquisition in the western "grain-farm" region. But although farm expansion from 1910 to 1930 may have offset farm abandonment as to the number of farms, a corresponding offset does not apply when the value of buildings is considered. In the regions of abandonment farm buildings averaged \$2,700 to \$3,100 in value, but in the regions of expansion they averaged only \$700 to \$2,200. This difference in value of improvements involves a corresponding difference in building-material requirements, which would make itself felt most acutely in the item of lumber.

AGRICULTURAL DEPRESSION

In addition to the halt in agricultural expansion, and of greater significance in the 1928 rural lumber consumption as estimated in table 3, was the enforced curtailment in normal repairs and replacements on account of the agricultural depression that set in immediately after the World War. Such records as are available indicate that expenditures for building repair and replacement on the farms in 1928 were about half those for 1912, after correcting for price index.

On the pre-war estimate of 2,000 feet per farm as the normal annual lumber requirements for repairs, and new construction, a total of 12½ billion board feet may be figured as required for the Nation's 6,400,000 farms in 1912. Another 2½ billion feet annually may be added for rural other than farm construction, making the total rural lumber consumption for 1912 about 15½ billion board feet.¹ If, as explained later, the drop in agricultural expansion reduced this by 4½ billion board feet a year, there would remain a requirement of 11 billion board feet for normal repair and replacement. When again approximately half of this amount is deducted for the loss due to post-war agricultural depression, an estimated rural consumption of only some 5½ billion board feet remains for 1928.

This, it is believed, is a fairly dependable check on the figure of 5½ billion board feet assumed in table 3, and its significance does not rest on the accuracy of the division as between agricultural expansion and depression. Decline in lumber consumption due to slowing up of agricultural expansion may have been less than 4½ billion board feet and the decline due to post-war depression more than 5½ billion board feet, but the conclusion is inescapable that these two conditions are the major factors in declining rural lumber consumption trends since 1912.

COMPETITION OF MATERIALS IN URBAN CONSTRUCTION

RESIDENTIAL

Urban and rural-urban² population, increasing at the rate of 2 million inhabitants annually from 1920 to 1928, set up a requirement for some 480,000 new family-dwelling accommodations annually. There was also an accumulated shortage up to 1921 estimated at

¹ This is the estimate generally used for rural lumber consumption as of that period, and is the one used in table 3.

² Rural-urban is that part of the population, adjacent to urban centers, which is urban in character but outside the city limits.

from 1 million to 1½ million family accommodations. These requirements, along with the effects of a building boom, resulted in a volume of urban residential construction of some 700,000 family units in

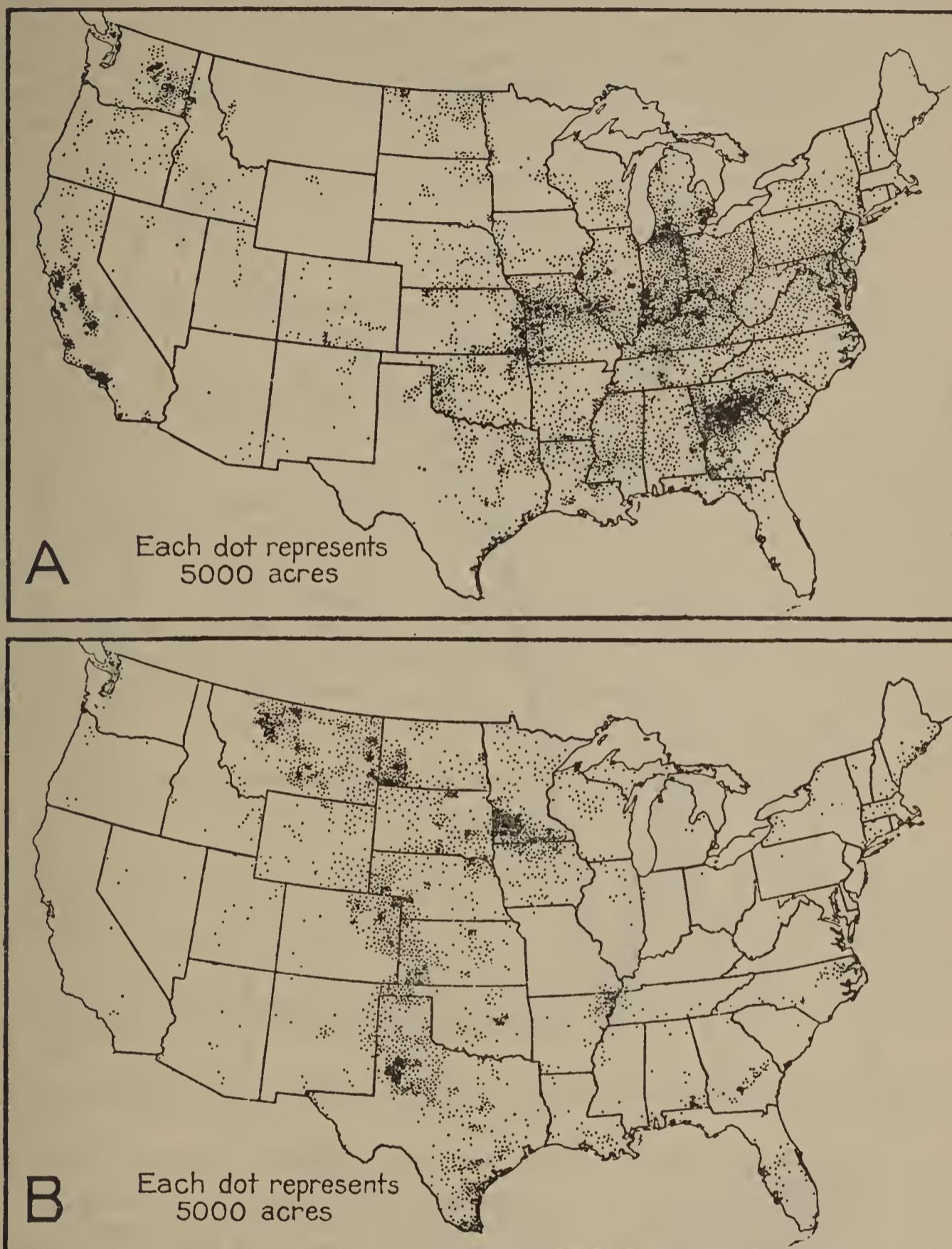


FIGURE 2.—Maps showing for period of 1919-24 decreases and increases in acreage of all harvested crops: A, decreases; B, increases (based on Census data).

1928. The abnormal volume of such construction from 1922 to 1928 is illustrated in figure 3.

The effect of this expansion on the use of wood is an interesting study. The small all-wood house apparently uses as much lumber as ever. But the all-wood house is not as common as it once was. There are more materials to choose from. In a six-room house that would require 20,000 feet of lumber, brick veneer may displace 2,800 feet of 10-inch siding, or fiber board may displace 3,000 feet of lumber for

sheathing; nor does this take any account of the materials that may displace wood lath and shingles, which are not measured as lumber.

In multifamily housing the displacement of lumber by other materials to date has been even more pronounced than in the single-family dwelling. This type, which has developed almost entirely since 1912, made up some 50 percent of new housing by 1928. New multifamily housing is quite generally either of masonry-wall or all-

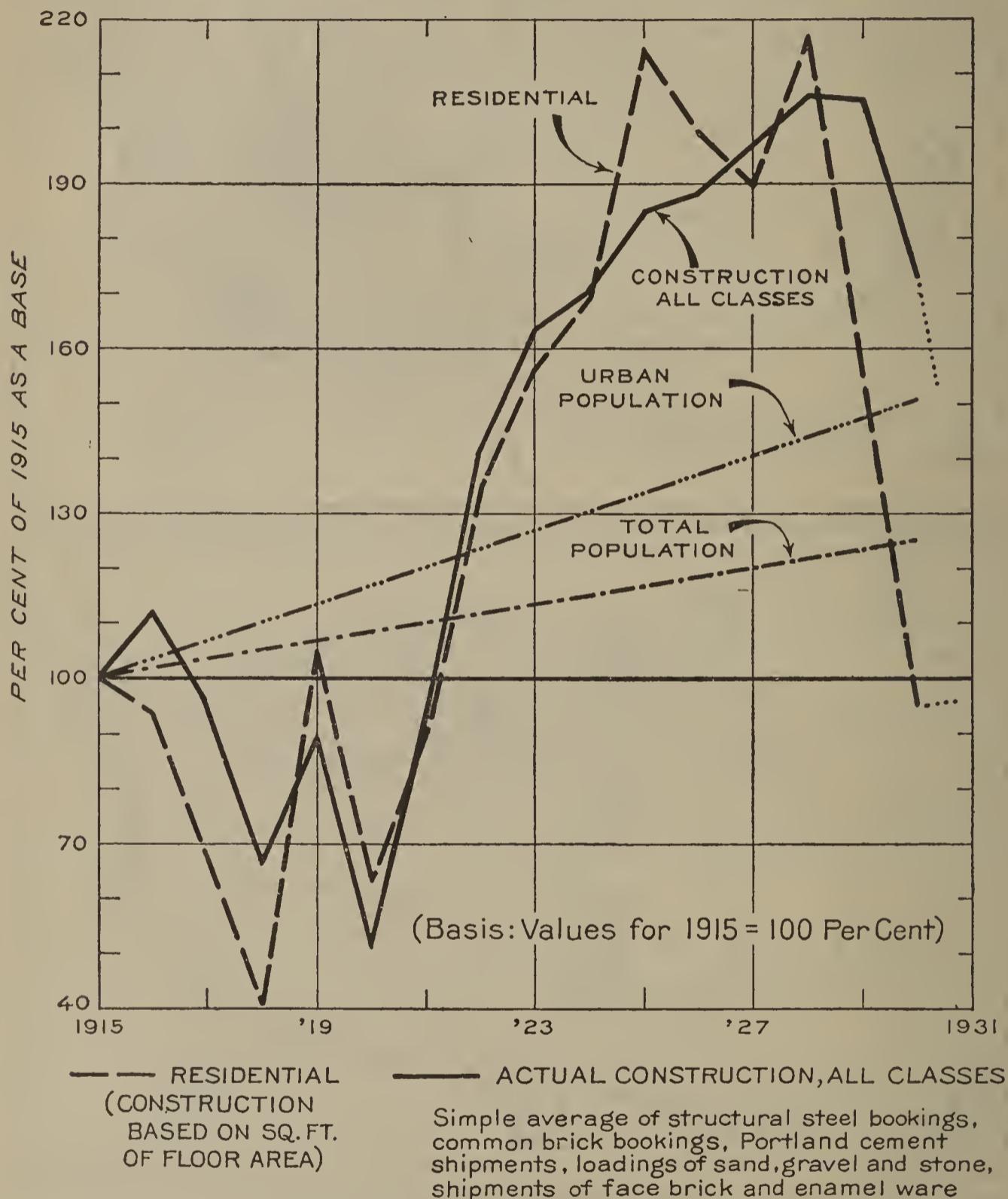


FIGURE 3.—Construction trends: Residential and all classes as related to urban and total population.

fireproof construction, and involves a reduction in floor area per person. It is estimated that use of other materials and reduction of floor area in multifamily housing reduced lumber requirements for total new housing in 1928 by 20 or 25 percent per family as compared with 1912. If multifamily housing alone can account for such a decline, 25 percent would be a conservative estimate for the relative displacement of lumber in single- and multiple-unit urban residential construction during the period considered.

On the basis of 20,000 board feet of lumber for the average single-family dwelling of 1,500 square feet floor area, the lumber requirements for 700,000 such units would be 14 billion board feet, and about 15 percent for repairs would make an estimated total annual requirement of 16 billion board feet. But reduction by a factor of 25 percent, as explained above, leaves an actual lumber requirement of 12 billion board feet for urban residential construction in 1928, as set up in table 3. The 1912 estimate of 9 billion board feet is based on residential construction of some 400,000 family units, considering only a small percentage as represented by multifamily housing of fireproof construction.

URBAN NONRESIDENTIAL

The above assumptions as to 1928 lumber consumption in rural construction and urban residential construction leave a balance of 5.4 billion board feet in 1928 and 5.3 billion board feet in 1912 to be accounted for in urban construction other than residential. In 1928 construction for railroad companies (excluding car construction, which comes under factory consumption, and ties, which are reported separately) accounted for a billion board feet. Commercial, educational, and public buildings accounted for another billion board feet. There is left 3.4 billion board feet for wharves, highways, engineering works, and all miscellaneous construction. While the estimated lumber consumption in all nonresidential construction was about the same in 1928 as in 1912, records show that the 1928 volume of construction was twice that of 1912. That is, relative lumber consumption in this field was reduced one half by the use of other materials.

LUMBER CONSUMPTION IN FACTORY PRODUCTS

Lumber consumed in fabricated products or by wood-using industries ranges from one fourth to one third of our total lumber consumption. Requirements in this field for 1928 were only a billion feet below the 1912 figure, a decrease of less than 8 percent. The statistics for comparison, principally from Forest Service studies in the wood-using industries, are given in table 4.

TABLE 4.—*Lumber consumed in fabricated products and by wood-using industries. 1912 and 1928*

Products	1912	1928
	<i>M ft. b.m.</i>	<i>M ft. b.m.</i>
Boxes and crates	4,550,016	4,981,230
Car construction	1,262,090	1,009,408
Furniture	944,678	1,198,612
Vehicles and vehicle parts:		
Nonmotor	569,144	80,841
Motor	170,000	867,875
Total of 4 principal industries	7,495,928	8,137,966
Woodenware, novelties, and dairymen's, poulterers', and apiarists' supplies	405,286	183,336
Agricultural implements	321,239	142,943
Chairs and chair stock	289,791	165,392
Handles	280,235	124,654
Musical instruments	260,195	107,502
Tanks and silos	225,620	66,328
Ship and boat building	199,598	128,342
Fixtures	187,133	130,030
Caskets and coffins	153,395	156,108
Refrigerators and kitchen cabinets	137,616	145,745
Matches and toothpicks	85,442	123,426

TABLE 4.—*Lumber consumed in fabricated products and by wood-using industries, 1912 and 1928—Continued*

Products	1912	1928
	<i>M ft. b.m.</i>	<i>M ft. b.m.</i>
Laundry appliances	79,502	38,674
Shade and map rollers	79,292	24,236
Paving material and conduits	76,067	3,350
Trunks and valises	74,668	21,346
Machine construction	69,459	39,627
Boot and shoe findings	66,240	48,742
Picture frames and moldings	65,478	20,947
Shutters, spools, and bobbins	65,148	44,022
Tobacco boxes	64,127	38,429
Sewing machines	59,947	12,760
Pumps and wood pipe	55,827	10,831
Pulleys and conveyors	35,863	900
Toys	28,927	39,410
Gates and fencing	27,451	1,572
Sporting and athletic goods	25,192	29,973
Patterns and flasks	24,299	29,996
Bungs and faucets	21,112	2,980
Plumbers' woodwork	20,313	16,273
Pencils and pen holders	20,041	39,982
Electrical machinery and apparatus	18,189	66,750
Mine equipment	16,988	22
Professional and scientific instruments	15,030	15,510
Brushes	12,879	17,033
Dowels	11,981	15,087
Elevators	10,019	46
Saddles and harness	9,218	751
Playground equipment	9,065	4,672
Butchers' blocks and skewers	8,197	4,888
Clocks	7,894	3,511
Signs and supplies	6,888	48,597
Printing material	5,325	5,984
Weighing apparatus	5,022	19
Whips, canes, and umbrella sticks	4,947	1,250
Brooms and carpet sweepers	2,277	28,452
Firearms	2,094	1,741
Artificial limbs	687	698
Tobacco pipes	490	1,411
Airplanes	74	9,044
Motion pictures and theatrical scenery		16,223
Total of 50 minor industries	3,651,767	2,179,545
Total, all uses	11,147,695	10,317,511

The first four items—boxes and crates, car construction, furniture, and vehicles—represent roughly 80 percent of the total factory consumption for 1928. Requirements for these 4 increased 9 percent from 1912 to 1928, whereas requirements for the other 50 items, which account for only 20 percent of total consumption, decreased about 1.5 billion feet, or, roughly, 40 percent.

BOXES AND CRATES

Consumption of lumber for boxes and crates is by far the largest item in factory consumption of lumber, and in 1928 it amounted to nearly half the total. The 1928 consumption, while 10 percent greater than that in 1912, represents a decline of 18 percent from a peak of 6 billion board feet in 1914, and this despite a 25 percent increase since 1918 in tonnage of package freight. The competition of fiber boxes accounts for the difference.

Competition between lumber and fiber board for boxes rests chiefly on costs to the user. The average wooden box weighs about three times as much as a fiber box of the same size. Freight and handling charges on the wooden box, however, may be somewhat less than three times what they are on the fiber box, because the

former averages larger and distributes the charges over larger contents. Improvements in design and construction have reduced the weight of wooden boxes about 25 percent in the last 10 years.

Further reduction could be made by more general application of information now available, but this would not materially broaden the field of wooden containers, as the main reduction in weight would come in the large sizes where there is as yet little competition from fiber. Changes that are taking place in transportation and handling methods favor the fiber box. From present indications it does not seem likely that lumber requirements for boxes and crates will go above the 1928 figure, and a decline is not improbable.

CAR CONSTRUCTION

The use of lumber in railroad car construction in 1928 showed a decline of 252,682,000 board feet, or 20 percent, as compared with 1912. This was most likely due to a lesser volume of construction rather than to disuse of wood as such. That freight-car construction fluctuates violently is shown by such figures as 335,000 cars built in 1905 and 65,000 in 1908; 190,000 in 1909 and 98,000 in 1910; 180,000 in 1912 and 80,000 in 1914; 98,000 in 1925 and 72,400 in 1927. There has been a great change in type of freight-car construction as affecting consumption of lumber, but most of this change developed prior to 1912. The 275,000 all-wood freight cars built in 1905 constituted 82 percent of all cars; in 1910 the 38,000 all-wood cars were only 39 percent; in 1912, 8,500 such cars were 4.7 percent; in 1925, 7,700 amounted to 7.9 percent; and in 1927, the 350 all-wood cars made up less than 0.5 percent of the total.³ But in the part-wood freight car the changes in design that are being made constantly are not greatly changing the average wood consumption per car, which in 1912 was about 2,000 feet. Passenger cars, which are few in number as compared with freight cars, show a similar trend away from wood construction.

FURNITURE

Consumption of lumber for furniture increased by more than a quarter of a billion board feet from 1912 to 1928, or 25 per cent. This is not so far out of line with the increase in population as to indicate increasing displacement of lumber by other materials.

More recent statistics from the Census Bureau throw valuable light on the trend as between wood and metal furniture. From 1925 to 1929 metal furniture increased 17½ percent in factory value, while wood furniture (including fiber, rattan, reed, and willow) made a 10 percent gain. The entire gain for metal was in furniture and fixtures for offices, stores, and public buildings, and for laboratories, hospitals, barber shops, and the like. The use of metal actually fell off 31 percent in factory value in household furniture, while use of wood increased 7 percent.

Metal furniture made up only 5 percent of the value of household furniture in 1929. On the other hand, it contributed one third of the value of furniture and fixtures not for household use, and here it had held its own for several years.

³ From Report No. 117, U.S. Department of Agriculture.

MINOR FACTORY ITEMS

The more conspicuous changes in minor factory items have occurred as the result of social and economic changes and in many instances are largely compensatory. For example, the development of the automobile and motor truck vastly curtailed buggy and wagon requirements, but in so doing it actually increased the use of wood. In fact, most of these developments indicate, not the direct competition of other materials with wood, but rather a change in services which producers of lumber and wood products may or may not have been prepared to meet.

In some of the most modern and popular items, an upward trend of wood consumption as between 1912 and 1928 may be confusing. Thus, the annual production of motor vehicles increased 21 percent from 1924 to 1928, but lumber consumption in motor vehicles dropped 4 percent, indicating a decline in amount of lumber per vehicle. Similarly, while consumption of lumber for airplanes has increased since 1912, the amount of wood per plane has decreased in favor of other materials.

The amount of plumbing has increased from 1912 to 1928, but the use of lumber for plumber's work has decreased, as table 4 shows. Manufacture of laundry appliances has more than doubled during the period, but the amount of lumber used in such appliances shrunk one half. The same tendencies may be even more pronounced in other products.

TENTATIVE NORMAL LUMBER REQUIREMENTS

Table 5 presents an estimate of normal annual lumber requirements for the country in its present stage of general development. The total arrived at is 31 to 34 billion feet. By normal requirements are to be understood the volume of consumption that may logically be expected when general economic conditions are such that the country is conscious neither of depression nor of unusual prosperity. It thus needs no proof that normal consumption will not be attained under the stress of the existing general depression, or the agricultural depression of earlier origin, which held rural construction below normal while industrial expansion was pushing urban construction far above normal.

TABLE 5.—*Estimated normal lumber consumption as of 1930 in comparison with totals for 1912 and 1928*

Class of use	1912	1928	Estimated normal 1930
	Billion ft.b.m.	Billion ft.b.m.	Billion ft.b.m.
Rural construction	15.0	5.5	10.0
Urban residential	9.0	12.0	6-8.0
Urban nonresidential	5.3	5.4	3-3.5
Sash, doors, and millwork	2.5	3.3	2-2.5
Factory products	11.2	10.3	10.0
Total	43.0	36.5	31-34.0

For the sake of the argument, however, let the normal present lumber requirements estimated in the table be assumed as a base line. The translation of these figures into normal long-time trends will

depend very much on such influences as population, national wealth, and economic organization. Stabilization of population, changes in design and construction practices, the use of new materials, multi-family housing, and changes to extensive farming in some regions and to intensive in others will have a direct effect on normal lumber consumption for residential and farm building construction. Deviations from normal in one line of consumption may have much or little effect in another. Separate consideration of each major line of consumption is necessary, both as to direction of trend and percentage of total volume.

With a return of normal agricultural conditions there is a prospective increase of some 5 billion board feet over the 1928 rural lumber consumption. Is the currently reported city-to-farm movement likely to add appreciably to this potential market recovery? If recovery of urban residential construction involves a return to a lower price class, where the all-wood house has predominated, how will that be reflected in lumber consumption? The answer to such questions would shed much-needed light on future lumber requirements. Indications point to a steadily declining birth rate and a national population figure approaching stability between 1950 and 1970. A prospective increase in population of only 10 million persons from 1930 to 1940 would require proportionately less living accommodations than the 16-million increase from 1920 to 1930. Against this trend the increasing age of existing construction is to be considered. The number of dwellings has doubled in the 40 years since 1890, so that in the greater proportion of dwellings, the replacement factor has not had time to develop. A 60-year replacement factor, for example, applied to present dwelling accommodations would eventually set up a requirement, even with a stable population, for some 450,000 new family units annually, which was approximately the pre-war rate.

HARDWOODS VERSUS SOFTWOODS

The declining consumption of lumber is reflected about equally by hardwoods and softwoods since 1906, as shown in table 1. From 1919 to 1928 hardwoods represented some 19 percent of total lumber consumed, as against perhaps 23 percent in the period 1909 to 1918. Much the same factors are at work in both hardwood and softwood consumption, although perhaps not to the same degree in specific cases. Changing rural demand would no doubt affect softwoods more than hardwoods, as would also the use of brick veneer, stucco, or other exteriors in place of wood in urban residential construction. On the other hand, the sustained use of wood in furniture manufacture means more in terms of hardwood than of softwood requirements.

There is also a factor of competition between hardwoods and softwoods. It is known that in the motor vehicle industry softwoods have displaced hardwoods for some purposes. The trend to upholstered furniture has meant some use of softwoods in place of hardwoods. Competition in wood flooring exists not only between different hardwoods, such as maple and oak, but also between hardwoods and softwoods.

The foregoing are only a few of the factors which must be seriously studied before future lumber requirements can be predicted with a satisfactory degree of assurance.

PULPWOOD REQUIREMENTS

STATISTICAL

Wood is today the preeminent raw material for the manufacture of paper, boards, and other fiber products, a fact that is clearly shown by table 6.

Attempts have been made from time to time, and are still being made, to pulp other fibrous plants, both cultivated and wild. Esparto, straws, bagasse, and cornstalks are being used with varying degrees of success. But wood is the most compact form of cellulose fiber

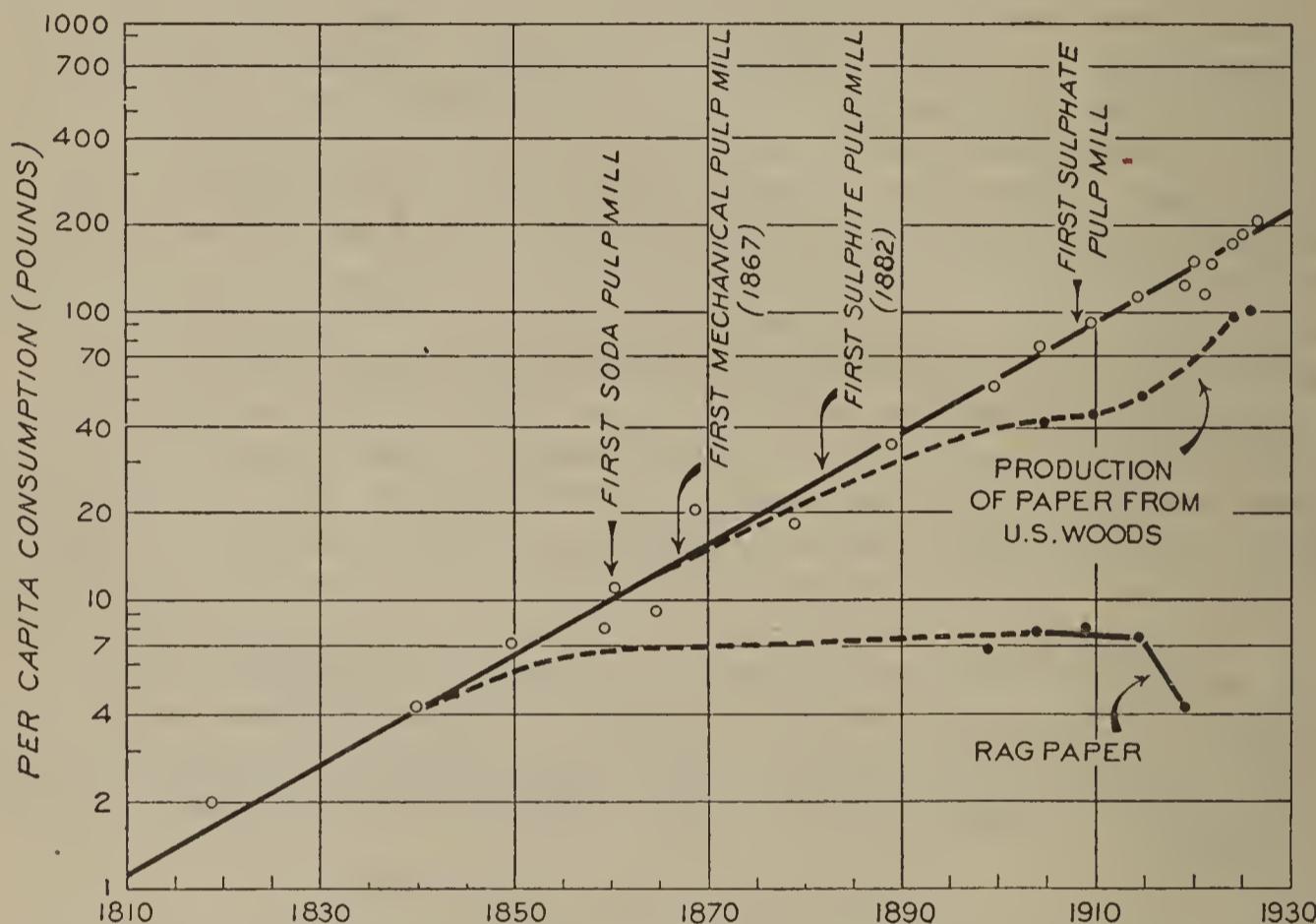


FIGURE 4.—Per capita consumption of paper and boards, as related to use of wood and rags

that exists in nature and is hence the cheapest and easiest raw material to handle. Wood pulp was first used as a substitute for rags in making paper only 70 years ago and today about 85 per cent of our paper has its origin in the forests.

Figure 4, plotted on logarithmic ordinates, shows that the trend of per capita consumption of paper has maintained a uniform rate of increase over a 120-year period, during which time wood pulp has displaced rags as the chief raw material, and domestic woods have failed to supply all our pulpwood requirements. Such a record of increasing use cannot be set aside, even though current consumption may indicate a change in trend. Increasing per capita consumption, together with increasing population, has brought our total paper consumption to $12\frac{1}{4}$ million tons in 1930 as shown in table 7.

TABLE 6.—*Raw materials consumed in United States paper manufacture*

Calendar year	Wood pulp ¹	Rags	Paper stock	Manila stock
	<i>Short tons</i>	<i>Short tons</i>	<i>Short tons</i>	<i>Short tons</i>
1879	22,570	200,005	87,840	84,786
1889	349,917	246,892	139,061	524,862
1899	1,172,880	234,514	356,193	99,301
1904	2,018,764	294,552	588,543	107,029
1909	2,826,591	357,470	983,882	117,080
1914	3,490,123	361,667	1,509,981	121,170
1919	4,019,696	277,849	1,854,386	116,994
1929	6,289,318	739,422	3,841,942	128,800

Calendar year	Straw	All other	Total raw materials	Total paper produced
	<i>Short tons</i>	<i>Short tons</i>	<i>Short tons</i>	<i>Short tons</i>
1879	245,838	1,218	642,257	452,107
1889	355,131	—	1,615,863	934,611
1899	367,305	—	2,230,193	2,167,593
1904	304,585	—	3,313,473	3,106,696
1909	303,137	29,422	4,617,582	4,216,708
1914	307,839	97,276	5,888,056	5,270,047
1919	353,399	106,850	6,729,174	6,190,361
1929	575,263	2,626,812	12,201,557	11,140,235

¹ Production: exports and imports, not reported, are assumed to be equal.² Reported as clay, rosin sizing, rosin, and casein.

Source: Bureau of the Census.

TABLE 7.—*Paper: Consumption by kinds and per capita, specified years beginning 1810¹*

Year	Newsprint		Book		Boards		Wrapping	
	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent
	<i>Tons</i>		<i>Tons</i>		<i>Tons</i>		<i>Tons</i>	
1899	569,000	26	314,000	15	394,000	18	535,000	25
1904	883,000	29	495,000	16	521,000	17	644,000	21
1909	1,159,000	27	689,000	16	883,000	21	763,000	18
1914	1,576,000	29	926,000	17	1,292,000	24	892,000	16
1917	1,824,000	29	846,000	14	1,805,000	29	814,000	13
1918	1,760,000	28	800,000	13	1,927,000	30	859,000	13
1919	1,892,000	29	838,000	13	1,940,000	30	825,000	13
1920	2,196,000	28	1,060,000	13	2,301,000	29	1,003,000	13
1921	2,002,000	33	707,000	11	1,641,000	27	770,000	13
1922	2,451,000	31	968,000	12	2,154,000	27	1,059,000	13
1923	2,814,000	30	1,235,000	13	2,802,000	30	1,177,000	13
1925	3,073,000	29	1,365,000	13	3,290,000	31	1,287,000	12
1926	3,517,000	30	1,408,000	12	3,637,000	31	1,435,000	12
1927	3,492,000	29	1,265,000	11	3,737,000	31	1,515,000	13
1928	3,561,000	29	1,321,000	11	4,009,000	32	1,457,000	12
1929	3,813,000	29	1,471,000	11	4,398,000	33	1,586,000	12
1930	3,496,000	28	1,370,000	11	4,014,000	33	1,556,000	13

¹ Imports added to United States production and domestic exports deducted.

TABLE 7.—*Paper: Consumption by kinds and per capita, specified years beginning 1810—Continued*

Year	Fine		All other		All kinds, quantity	Per capita, pounds
	Quantity	Percent	Quantity	Percent		
					<i>Tons</i>	
1810					2 3,000	1
1819					2 12,000	2
1839					2 38,000	4
1849					2 78,000	7
1859					2 127,000	8
1869					391,000	20
1879					457,000	18
1889					1,121,000	36
1899	113,000	5	233,000	11	2,158,000	57
1904	142,000	5	365,000	12	3,050,000	74
1909	193,000	5	537,000	13	4,224,000	93
1914	244,000	4	566,000	10	5,496,000	112
1917	276,000	4	691,000	11	6,256,000	122
1918	348,000	5	693,000	11	6,387,000	123
1919	306,000	5	692,000	10	6,493,000	124
1920	371,000	5	930,000	12	7,861,000	148
1921	230,000	4	704,000	12	6,054,000	112
1922	356,000	4	1,015,000	13	8,003,000	146
1923	374,000	4	938,000	10	9,340,000	167
1925	472,000	5	1,103,000	10	10,590,000	184
1926	495,000	4	1,315,000	11	11,807,000	203
1927	502,000	4	1,404,000	12	11,915,000	202
1928	538,000	4	1,562,000	12	12,448,000	208
1929	593,000	4	1,490,000	11	13,351,000	220
1930	564,000	5	1,251,000	10	12,251,000	199

² Domestic production only, value of exports and imports being approximately equal. No data for 1829.

A computed table based on data credited in the tables of compiled record. Printed as table 3, U.S.D.A. Bulletin 1241, 1810-1922. Tons of 2,000 pounds.

ANALYSIS OF TRENDS IN PAPER CONSUMPTION

The products designated as paper fall into six general classes—fine, book, newsprint, wrapping, boards, and all other. Table 7 and figure 5 afford a comparison of these classes in relation to total use.

NEWSPRINT

Of all papers newsprint is the most important, being exceeded in volume only by boards. Demand for newsprint for newspaper publication is concentrated in the large cities, nearly 90 percent of the total production being consumed by 15 percent of our dailies.⁴ Total consumption of newsprint increased 60 percent from 1920 to 1930, and since newspaper circulation increased only 37 percent in that period,⁵ it is evident that size of issue is also a large factor in consumption. This is borne out by figure 6 which shows increasing bulk of newspapers and increasing pounds per capita following same general trend. Numbers of pages are based on 1 week's figures per year for 10 papers taken at random from different sections of the country. They are not necessarily the average for the country, but are considered as indicative.

Back of the growth in newspaper circulation are, of course, the factors of literacy and population increase, more particularly in urban centers. Urban population increase in the United States during the last decade was the largest it has ever been. As the increase becomes less that factor will diminish.

⁴ From a report by H. A. Laird, manager, traffic department, Chicago Tribune, 1930.

⁵ From a report by R. S. Kellogg of the Newsprint Service Bureau, Oct. 27, 1931.

What the future size of our newspapers will be is more difficult to estimate than is the probable circulation trend. Advertising largely controls the number of pages, and reports indicate that a decline in advertising since 1926 has reduced the size of newspapers from a maximum presumably occurring in that year. Advertising will in all probability recover from the depression along with other commercial activities, but there is now the question of competition between forms of advertising. H. A. Laird has estimated that the newspapers'

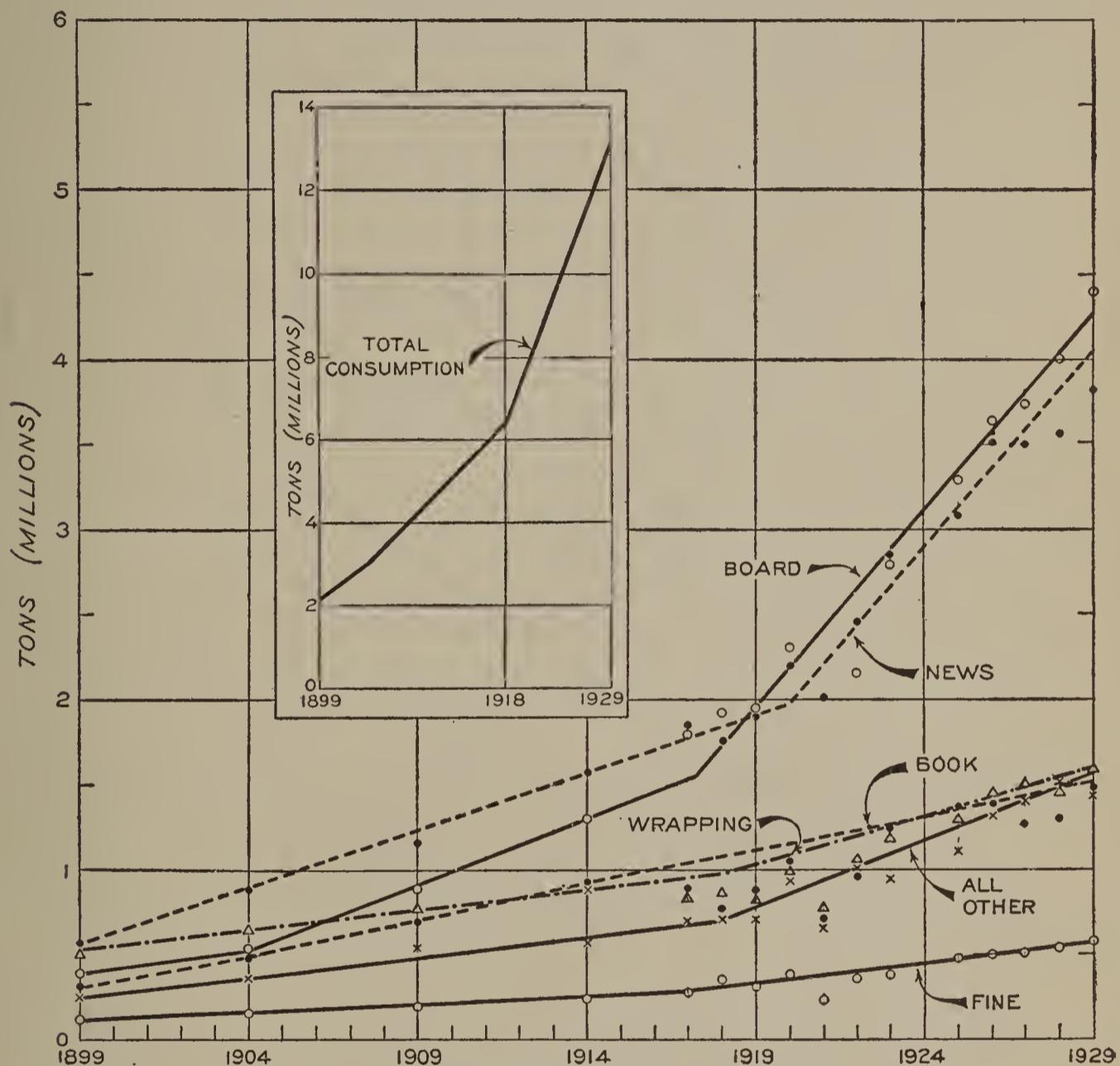


FIGURE 5.—Paper consumption by kinds.

share of the total spent for advertising in 1922 was 62½ percent, but only 46 percent in 1929.

BOARDS

On a gross tonnage basis boards have taken first place from newsprint. (See fig. 5.) They fall far below newsprint, however, in pulp requirements. Only some 20 percent of boards, by weight, is new pulp, the remainder being supplied chiefly by reuse of waste paper.

Container board is the largest item, and there is reason to believe that the saturation point for such boards has not yet been reached. The increasing demand for fiber containers is clearly due to the far-reaching change from bulk to package handling of commodities. Package freight originating on class 1 railroads, for example, increased more than 25 per cent from 1920 to 1928, a time when there was no

increase in total freight originating on these roads. Further increase in the use of fiber containers is favored by changes in transportation and handling methods which reduce shipping hazards, by the economies possible with prepacking of merchandise, and by the probability that research will further improve and strengthen the fiber box.

Fiber boards as construction material are a comparatively late development, but their use for insulation against heat, cold, and sound, for concrete forms, and for various temporary purposes has grown rapidly. Boards of this character, aggregating more than 120,000 tons in 1927, are not included in the statistics for paper consumption. Some of them are made of straw, some of cornstalks, some of cane,

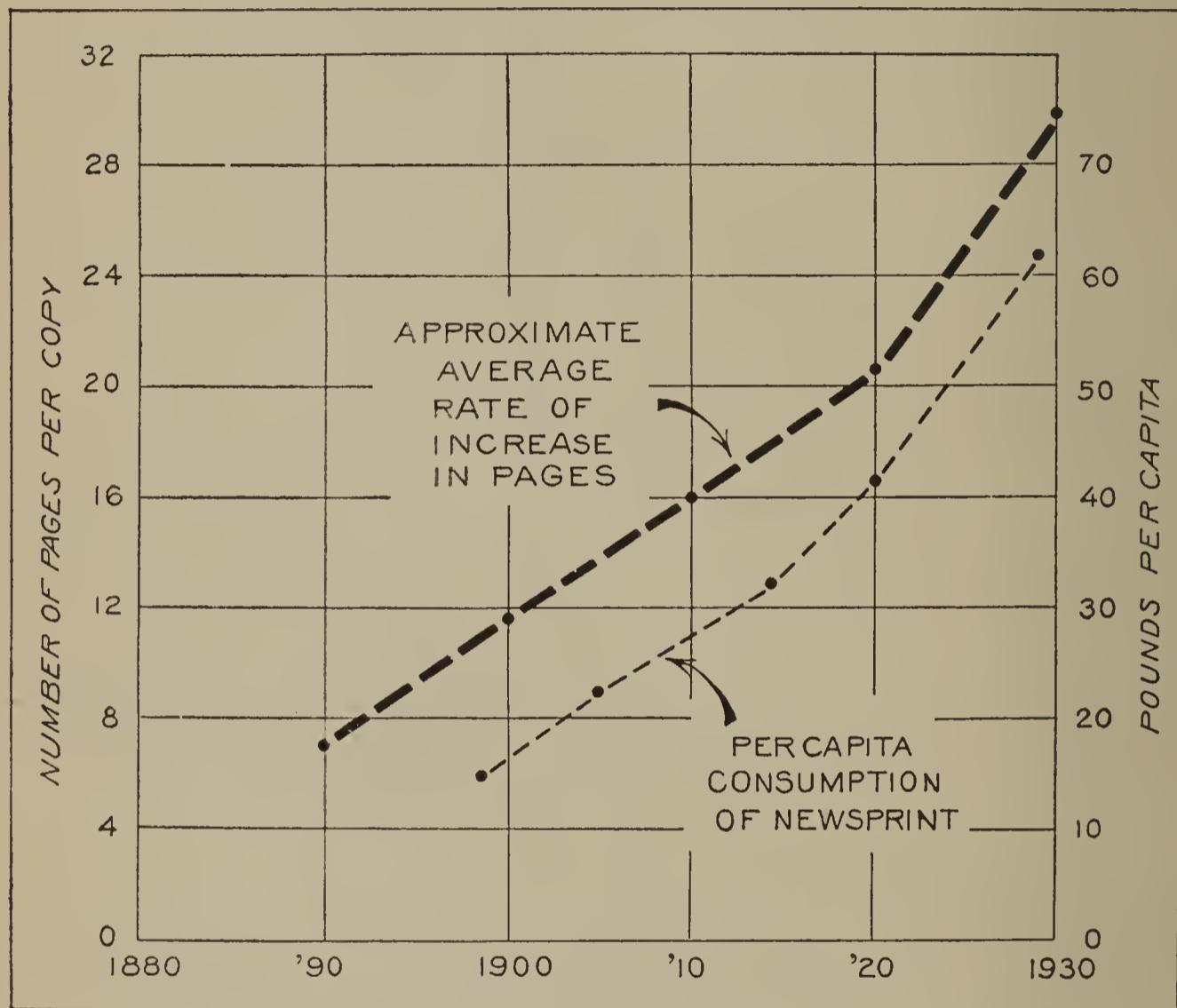


FIGURE 6.—Increase in number of pages per copy of daily papers since 1880.

and some of wood. A demand for them has been established, and the prospects are that their use will increase.

OTHER PAPERS

Fine papers constitute only about 5 percent of all pulp products and have held closely to this proportion for 30 years. Consumption of both book and wrapping papers has doubled in the last 20 years, but the percentage fell from 16 or 18 percent of total paper consumption in 1909 to about 12 percent in 1929. All other paper consumption has held to about 12 percent of the total for the past 30 years.

FUTURE PAPER REQUIREMENTS

The forecasting of paper requirements presents in some respects an even more difficult problem than that of lumber requirements. In

the attempt to anticipate lumber requirements the factors dealt with have more or less stability, once they are definitely set up. That there should be a dwelling for every family, for example, would probably be generally accepted, and there is little point in considering a prospect of two dwellings per family. Size of family and size of dwelling are changing, but reasons for the changes are evident and the trends can be set up as normal.

On the other hand, there is as yet no accepted standard for the number and quantity of newspapers per family. In Washington, D.C., the average for the city is $2\frac{1}{2}$ daily papers per family, whereas rural sections can no doubt be found where there are no daily papers. Will the saturation point be 1, 2, or more daily papers per family? Further, how large is the daily paper to be? Similar questions may be raised as to books and magazines. There is still a large undeveloped field for all cultural paper products. Will it remain undeveloped?

Requirements for boards and probable new paper products are equally uncertain. There is no allotment per capita or per family that can be recognized as marking the saturation point, nor can anyone say when such a point will be reached.

Referring again to figure 5, it is seen that consumption of all papers increased at a greater rate after 1920 than before. If the trend after 1920 represents a new "normal," its continuation would suggest a total paper consumption of 28 million tons by 1950. On the other hand, the post-war increases may have been abnormal. Decline in consumption since 1929 is looked upon by some as marking a return to a lower basis. What that means is not at all definite, since paper consumption has certainly not suffered as severely in the present depression as have manufactures generally. A return to pre-war trends, however, would indicate a total paper consumption in the United States considerably below 28 million tons by 1950. Bernard Navarre, president of the Association of Paper Manufacturers of France, in a paper presented at the International Forestry Congress in Paris, in 1931, predicted that in 30 years world paper consumption will increase from 20 million tons to 60 million tons. If the United States retains its relative position, this is a forecast of over 30 million tons annual consumption here by 1960. A report by Charles W. Boyce, of the American Paper and Pulp Association, in October 1931, suggests a 1950 paper consumption of 24 million tons and equivalent pulpwood requirements of 22 million cords.

For conversion of total paper consumption to the equivalent of pulpwood, the rough relation of 1 cord of wood to a ton of pulp may be assumed. This ratio is subject to some variation depending, for example, upon the proportion of waste paper reused and the proportion of such reuse to total consumption. With boards holding closely to the general trend since 1918, no great change in the conversion factor is in sight. Timber requirements for pulpwood must also take into account the use of waste wood, which is small thus far, representing only some $7\frac{1}{2}$ percent of wood converted into pulp in the United States and some $3\frac{1}{2}$ percent of our total pulpwood requirements.

RAYON AND CELLOPHANE

Besides pulp requirements for paper manufacture, there is a relatively small but rapidly growing pulp requirement for other cellulose

products, of which the chief at present is rayon. Rayon is yet too new a product to permit its future pulp requirements to be estimated with any definiteness. Its status in only a few years has changed from that of "artificial silk" to a new textile in its own right, competing no longer with silk alone but also with cotton and even with wool.

The growth of the industry is outlined in the following paragraphs from Commerce Reports (of the Bureau of Foreign and Domestic Commerce) for March 21, 1932:

In 1911 American rayon yarn output was calculated at 320,000 pounds. Ten years later, in 1921, production had expanded to 15,000,000 pounds. Even more impressive than the 144,350,000 pound output of 1931 is the fact that within the trade it is stated that actual production capacity as of July 1931 was nearly 195,000,000 pounds.

Latest official records for the rayon industry of this country are those obtained in the 1929 census of manufacturers, revealing 28 producing plants as compared with only 19 in 1927, the date of the preceding census—practically a 50 percent expansion in 2 years. In the latter year there were 38,938 wage earners, with annual compensation totaling \$44,704,000. The aggregate value of products was \$149,276,000.

As to the amount of wood pulp used in the production of rayon in 1931, the following is quoted from the bulletin of the News Print Service Bureau for March 15, 1932:

The best estimates available are to the effect that approximately 52,000 tons of wood pulp were used for rayon in the United States last year. This is 5 percent of the consumption of bleached sulphite pulp and 2.4 percent of the total consumption of sulphite pulp, bleached and unbleached combined.

Estimates in the trade are to the effect that there were also made in the United States last year something like 80 million pounds of cellophane in which there was used perhaps 50,000 tons of bleached sulphite pulp.

Assuming that a like amount of sulphite pulp was used in our 1931 production of cellophane, the total pulp requirement for rayon and cellophane together may be estimated at 100,000 tons, which would represent about 5 percent of our sulphite pulp consumption and something like 10 percent of our domestic production of such pulp. How soon or how largely this estimate will be superseded remains to be seen.

IMPORTS IN RELATION TO PULPWOOD REQUIREMENTS

Imports are the largest single factor to be weighted in the conversion of pulp and paper consumption to domestic wood requirements. Table 8 shows what part of the imports have come to the United States as paper, what part as pulp, and what part as wood. Total requirements are here made to include our exports of paper in addition to home consumption. In 1899, 22 percent of the total requirements was supplied by foreign wood. The percentage increased steadily to 56 percent in 1925, and was 54 percent in 1930.

TABLE 8.—*Foreign contributions to United States paper requirements, specified years, beginning 1899*

Year	United States paper requirements in pulpwood equivalent			Imports from Canada ¹				
	Domestic consumption	Paper exports	Total	Pulp-wood ²	Wood pulp and its pulpwood equivalent	Tons	Cords	Paper and its pulpwood equivalent
	Cords	Cords	Cords	Cords	Tons	Cords	Tons	Cords
1899	1,950,000	125,000	2,075,000	369,000	31,511	51,000	88	-----
1904	3,259,000	138,000	3,397,000	574,000	113,585	183,000	11,879	6,000
1909	4,420,000	152,000	4,572,000	794,000	164,404	204,000	16,941	27,000
1914	5,886,000	185,000	6,071,000	830,000	316,735	422,000	282,279	378,000
1917	6,783,000	478,000	7,261,000	774,000	438,986	629,000	497,276	660,000
1918	6,366,000	500,000	6,866,000	745,000	571,675	973,000	606,132	805,000
1919	6,806,000	620,000	7,426,000	1,032,000	519,212	853,000	674,963	856,000
1920	8,300,000	433,000	8,733,000	1,099,000	655,144	1,129,000	720,439	921,000
1921	6,649,000	239,000	6,888,000	817,000	402,846	681,000	675,136	880,000
1922	9,148,000	235,000	9,383,000	1,050,000	645,416	1,120,000	926,977	1,204,000
1923	9,924,000	189,000	10,113,000	1,236,000	720,726	1,178,000	1,151,489	1,445,000
1925	10,733,000	232,000	10,965,000	1,088,000	880,453	1,438,000	1,354,913	1,709,000
1926	12,129,000	212,000	12,341,000	1,277,000	864,876	1,416,000	1,788,099	2,270,000
1927	12,197,000	239,000	12,436,000	1,224,000	776,999	1,288,000	1,897,307	2,414,000
1928	12,939,000	273,000	13,212,000	1,409,000	784,981	1,304,000	2,069,833	2,639,000
1929	13,780,000	417,000	14,197,000	1,242,000	802,665	1,313,000	2,359,117	2,957,000
1930	13,034,000	370,000	13,404,000	858,000	735,864	1,179,000	2,170,185	2,721,000

Year	Imports from Norway, Sweden, Finland, and Germany				Imports from all other countries			
	Wood pulp and its pulpwood equivalent		Paper and its pulpwood equivalent		Pulp-wood	Wood pulp and its pulpwood equivalent	Paper and its pulpwood equivalent	
	Tons	Cords	Tons	Cords	Cords	Tons	Cords	
1899	5,494	11,000	8,564	15,000	-----	312	1,000	6,919
1904	43,398	70,000	929	1,000	-----	5,189	8,000	59,021
1909	129,365	258,000	25,411	36,000	-----	13,354	27,000	12,054
1914	348,940	705,000	31,189	54,000	-----	9,890	20,000	12,741
1917	237,390	461,000	3,698	6,000	-----	1,465	1,000	16,184
1918	6,534	13,000	396	1,000	-----	-----	-----	12,449
1919	113,414	230,000	922	1,000	-----	3,390	6,000	7,800
1920	242,253	462,000	57,671	72,000	-----	8,900	15,000	15,580
1921	284,980	527,000	148,482	200,000	-----	9,274	18,000	18,420
1922	601,765	1,202,000	169,358	247,000	-----	11,054	21,000	28,800
1923	639,120	1,195,000	260,212	341,000	-----	23,310	40,000	32,846
1925	745,747	1,417,000	164,285	209,000	-----	37,414	70,000	24,124
1926	829,132	1,593,000	142,280	181,000	-----	41,725	81,000	32,079
1927	855,404	1,648,000	171,658	212,000	-----	41,365	80,000	41,782
1928	923,668	1,770,000	165,046	203,000	-----	46,314	90,000	44,990
1929	1,050,824	1,998,000	153,250	177,000	6,000	34,016	66,000	42,342
1930	1,065,778	2,005,000	179,207	211,000	238,000	28,575	56,000	42,577

PULPWOOD EQUIVALENT OF TOTAL IMPORTS

Year	From Canada		From Norway, Sweden, Finland and Germany		From all other countries		Total foreign contributions	Percentage of United States requirements
	Cords	Percent	Cords	Percent	Cords	Percent		
1899	420,000	92	26,000	6	12,000	2	458,000	22
1904	763,000	83	71,000	8	87,000	9	921,000	27
1909	1,025,000	75	294,000	22	43,000	3	1,362,000	30
1914	1,630,000	67	759,000	31	40,000	2	2,429,000	40
1917	2,063,000	81	467,000	18	23,000	1	2,553,000	35
1918	2,523,000	98	14,000	1	18,000	1	2,555,000	37
1919	2,741,000	92	231,000	8	8,000	-----	2,980,000	40
1920	3,149,000	85	534,000	14	35,000	1	3,718,000	43
1921	2,378,000	76	727,000	23	43,000	1	3,148,000	46
1922	3,374,000	69	1,449,000	30	62,000	1	4,885,000	52
1923	3,859,000	70	1,536,000	28	81,000	2	5,476,000	54
1925	4,235,000	71	1,626,000	27	98,000	2	5,959,000	54
1926	4,963,000	72	1,774,000	26	115,000	2	6,852,000	56
1927	4,926,000	71	1,860,000	27	123,000	2	6,909,000	56
1928	5,352,000	72	1,973,000	26	136,000	2	7,461,000	56
1929	5,512,000	71	2,175,000	28	113,000	1	7,800,000	55
1930	4,759,000	65	2,215,000	30	331,000	5	7,305,000	54

¹ Includes Newfoundland and Labrador.² Imported as such for consumption by mills in the United States.

A computed table based on data credited in the tables of compiled record. Combines table 27 and table 28, U.S.D.A. Bulletin 1241, 1899-1922. Tons of 2,000 pounds. Cords of 128 cubic feet.

If, according to Boyce's estimate, American paper consumption in 1950 is to be the equivalent of 22 million cords of wood, and if domestic wood hereafter supplies 45 percent of the total requirement, the consumption of domestic pulpwood in 1950 will be only 9.9 million cords. If domestic wood continues to lose ground in competition with foreign resources, the figure will be even less. However, with adequate timberlands of our own there is no justification for any plan that does not look to providing for total pulpwood requirements independent of imports.

The primary cause for rapid increase in our relative dependence upon foreign resources has been the insufficiency of pulpwood in our older spruce-pulp producing regions, that is, New England, New York, Pennsylvania, and the Lake States, to meet increased requirements. The industry has had to go to more distant sources, either at home or abroad. Figure 7 shows graphically how our newer regions have been developed from a comparatively small place in 1904 to supply half the domestic wood used in 1929. Consumption from this source increased nearly fourfold in the 10 years beginning in 1919. Even so, domestic wood was unable to hold its relative position in competition with imports, dropping from 60 percent of total requirements in 1919 to 45 percent in 1929.

Newer woods as well as newer regions occupy an increasing place in the domestic pulping industry, but without any great decrease in the relative amount of spruce in our total paper consumption. It is true that spruce wood, both domestic and imported, pulped in our own mills increased but little from 1904 to 1929, and furnished only 22 percent of our total wood requirements in 1929 as compared with 67 percent in 1904. (See fig. 8.) But assuming imports of pulp and paper to represent also requirements for spruce, which is more or less the case, then spruce supplied approximately 80 percent of our wood requirements in 1904, dropped to 70 percent in 1919, and has practically held that position since. The extent to which spruce continues to dominate the industry is sometimes lost sight of by considering only domestic pulp production.

In 1929 spruce represented some 46 percent of all wood consumed in domestic pulp production, hemlock 16 percent, pines 16 percent, and all other woods 22 percent. The use of hemlock may be taken to represent substitution for spruce in the production of mechanical and sulphite pulps, and the use of pine to represent a shifting of pulp production to sulphate.

The relative shift to broader bases of supply is further illustrated by figure 9. There has been little change in the quantity of mechanical pulp made from domestic wood since 1904, but whereas this wood constituted 32 percent of total wood requirements in 1904, it was only 9 percent in 1929; in the same period dependence on foreign timber resources for mechanical pulp increased from 10 percent to 18 percent of the total requirement. Domestic wood for sulphite pulp made up 36 percent of our requirements in 1904 and only 19 percent in 1930, while dependence on foreign resources increased from 15 percent to 28 percent of the total. The situation is almost reversed in the sulphate field. Sulphate pulp represented only 2 percent of total pulpwood requirements in 1909, practically all imported. By 1923, imports of sulphate pulp represented 6 percent of total wood requirements, but domestic production had grown up to the same proportions. By 1930

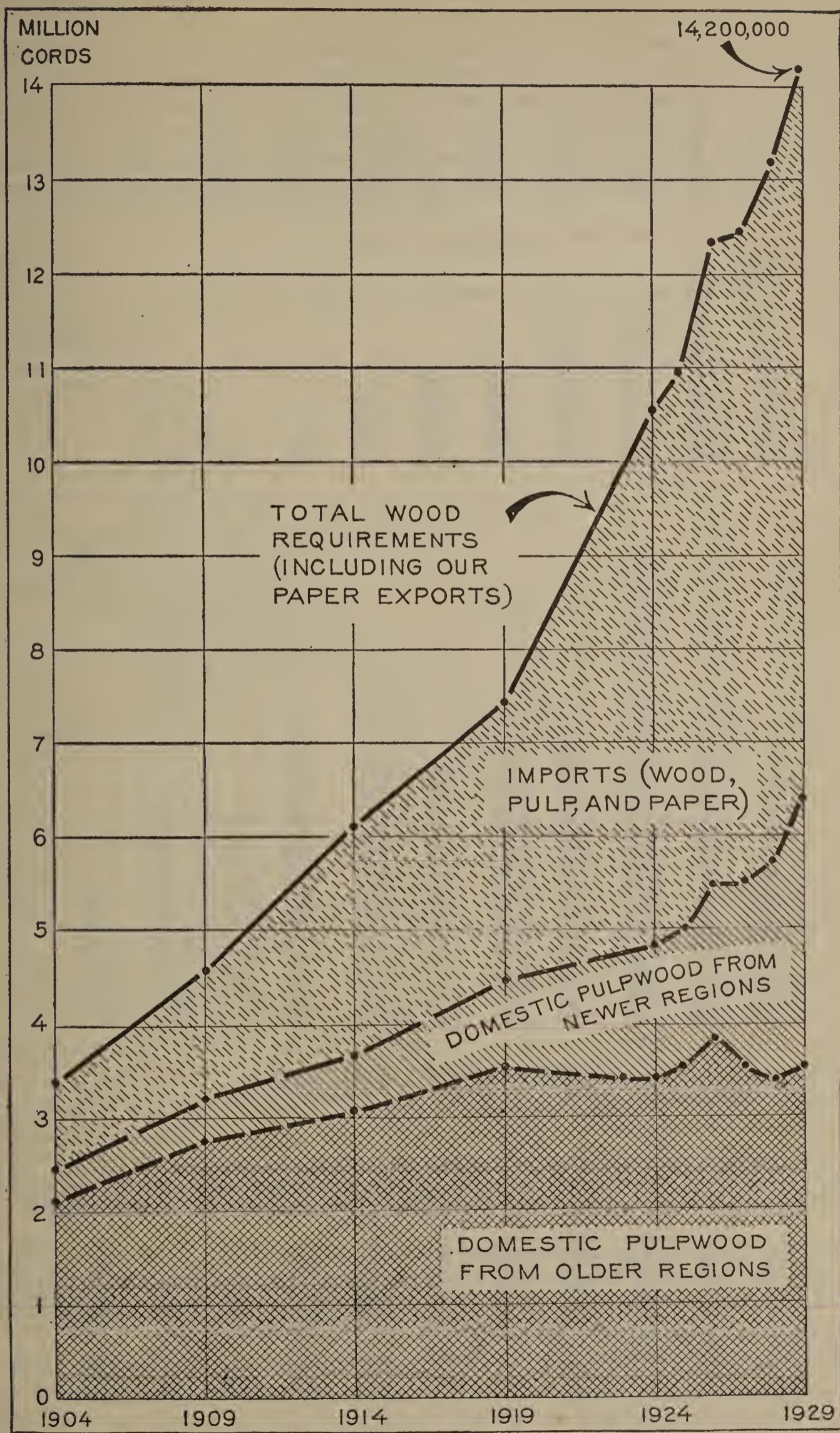


FIGURE 7.—Dependence on imports for our pulpwood requirements has increased despite development of new domestic sources.

domestic production had increased to 13 percent and imports were still only 6 percent of total requirements.

The significant fact illustrated by figure 9 is the importance of timber resources to our pulp and paper industry. Growth of domestic sulphate production in competition with imports is accounted for by the extension and adaptation of a pulping process to abundant wood resources of the South, and it goes far toward demonstrating that with an equally favorable raw-material situation domestic industry could

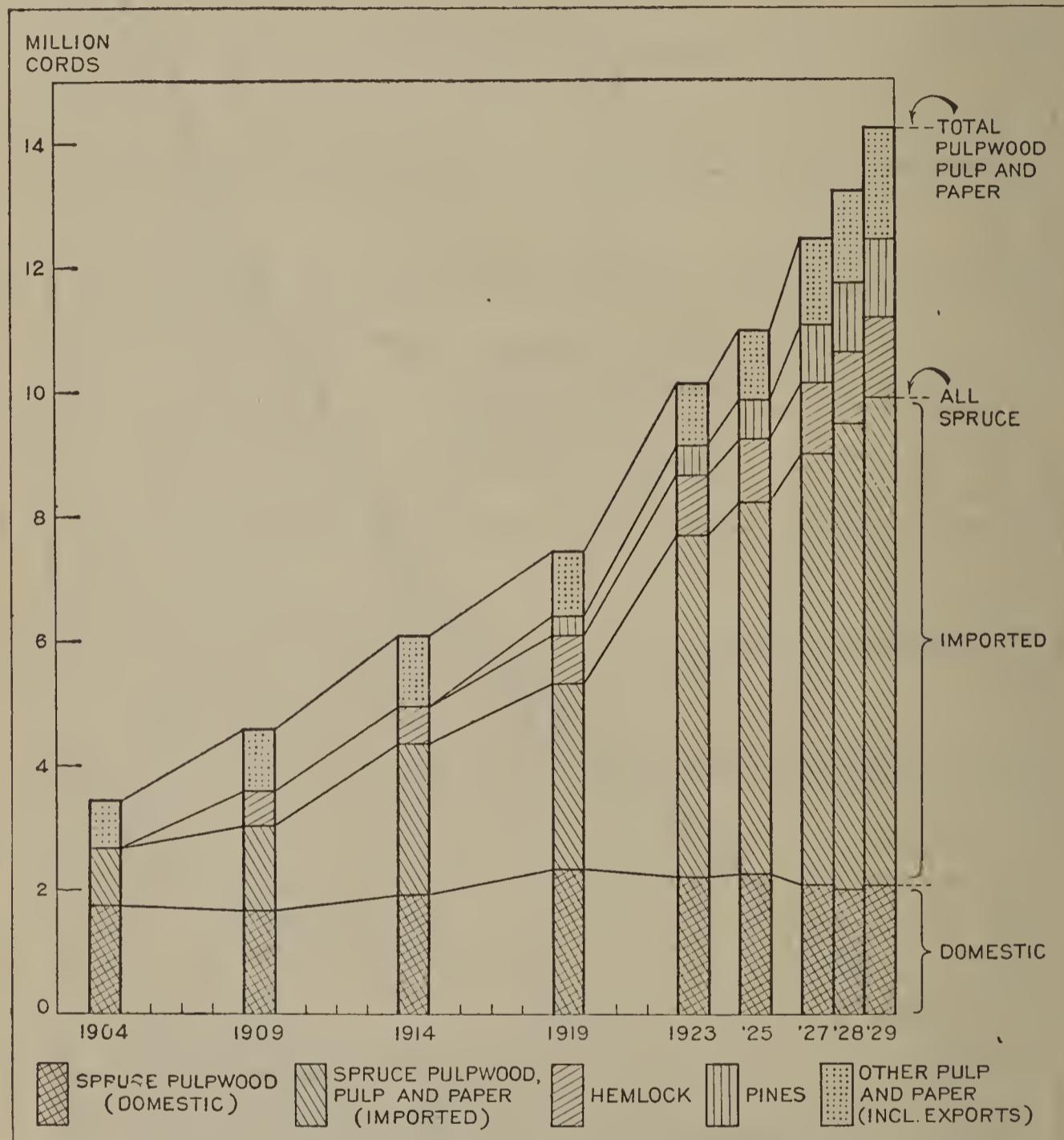


FIGURE 8.—Imports in relation to trends in pulpwood requirements—spruce versus other species. Spruce has dropped from 67 percent in 1904 to only 22 percent in 1929 of wood used in domestic production of pulp, but still made up 70 percent of total requirements in 1929 compared with 80 percent in 1904.

compete successfully in the mechanical and sulphite fields also. That should be a sound objective, whether it means growing of the pulpwood species now preferred by industry or adapting the pulping process to utilize other domestic woods, or both.

Development of the domestic industry provides a market for timber crops and employment for labor. Our present importation of the equivalent of 7 million cords of wood annually is equal to a timber crop from perhaps 7 million to 15 million acres, depending on growing conditions, and these figures may be doubled by 1950.

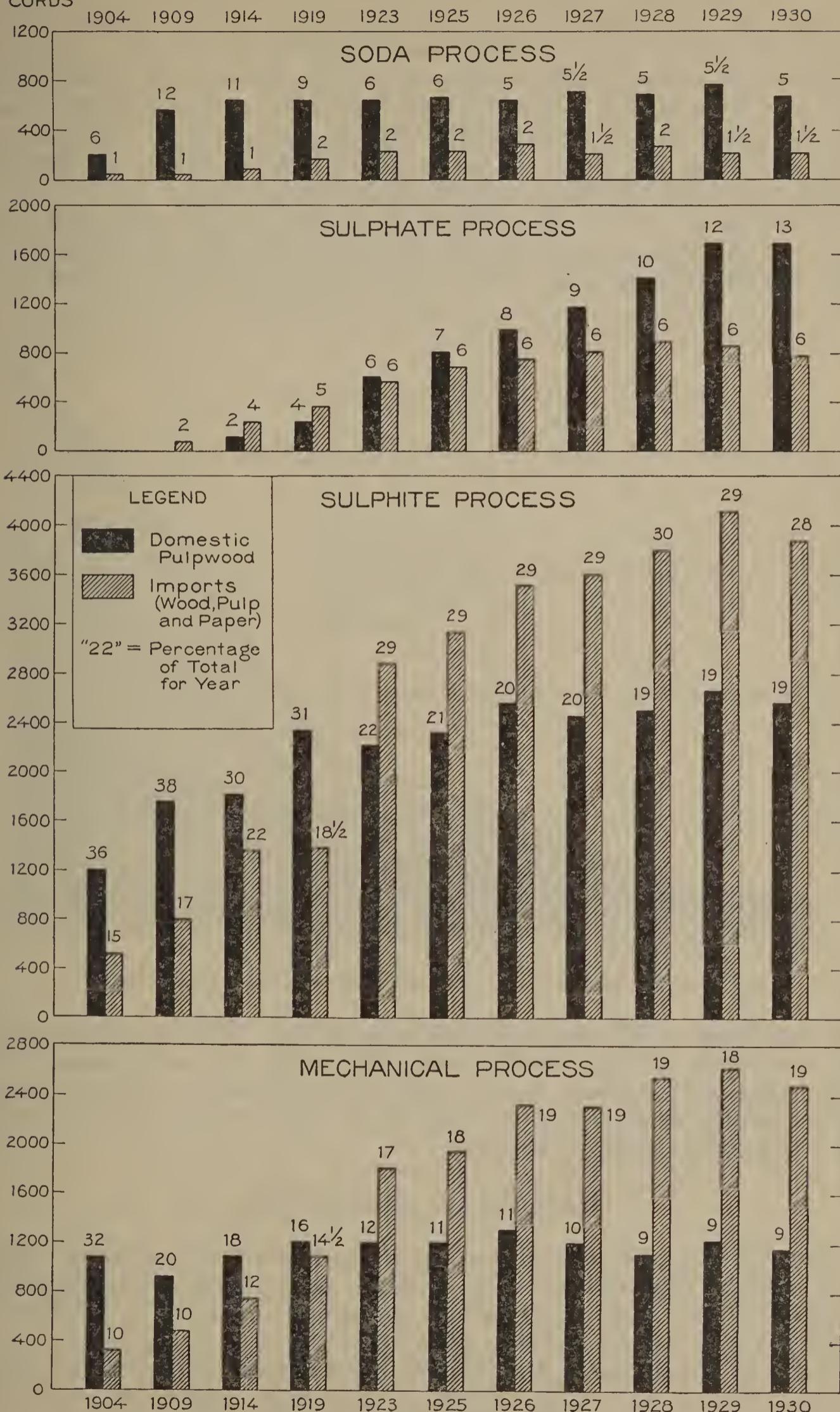
THOUSAND
CORDS

FIGURE 9.—The effect of ample supply of suitable wood is shown by the successful competition of domestic pulpwood with imports of wood, pulp, and paper in the sulphate field, contrasted with increasing dependence on imports for sulphite and mechanical pulps.

Pulpwood, pulp, and paper imports are shown in terms of wage earners employed in figure 10. The conversion is based on output per man in the production of both pulp and paper in the United States, as reported by the Bureau of the Census for 1929. Output per man has increased since then, but not enough to affect measurably the converting factor. Woods labor, which the census reports do not include, has also been taken into account on a basis of 300 cords of wood per man per year. This is all utilization labor, leaving the additional factor of labor in growing the timber crop.

On the above basis, our imports of foreign pulps, pulpwoods, and paper as of 1929 were equivalent to full-time employment for more than 70,000 wage earners, which is nearly half as many as were actu-

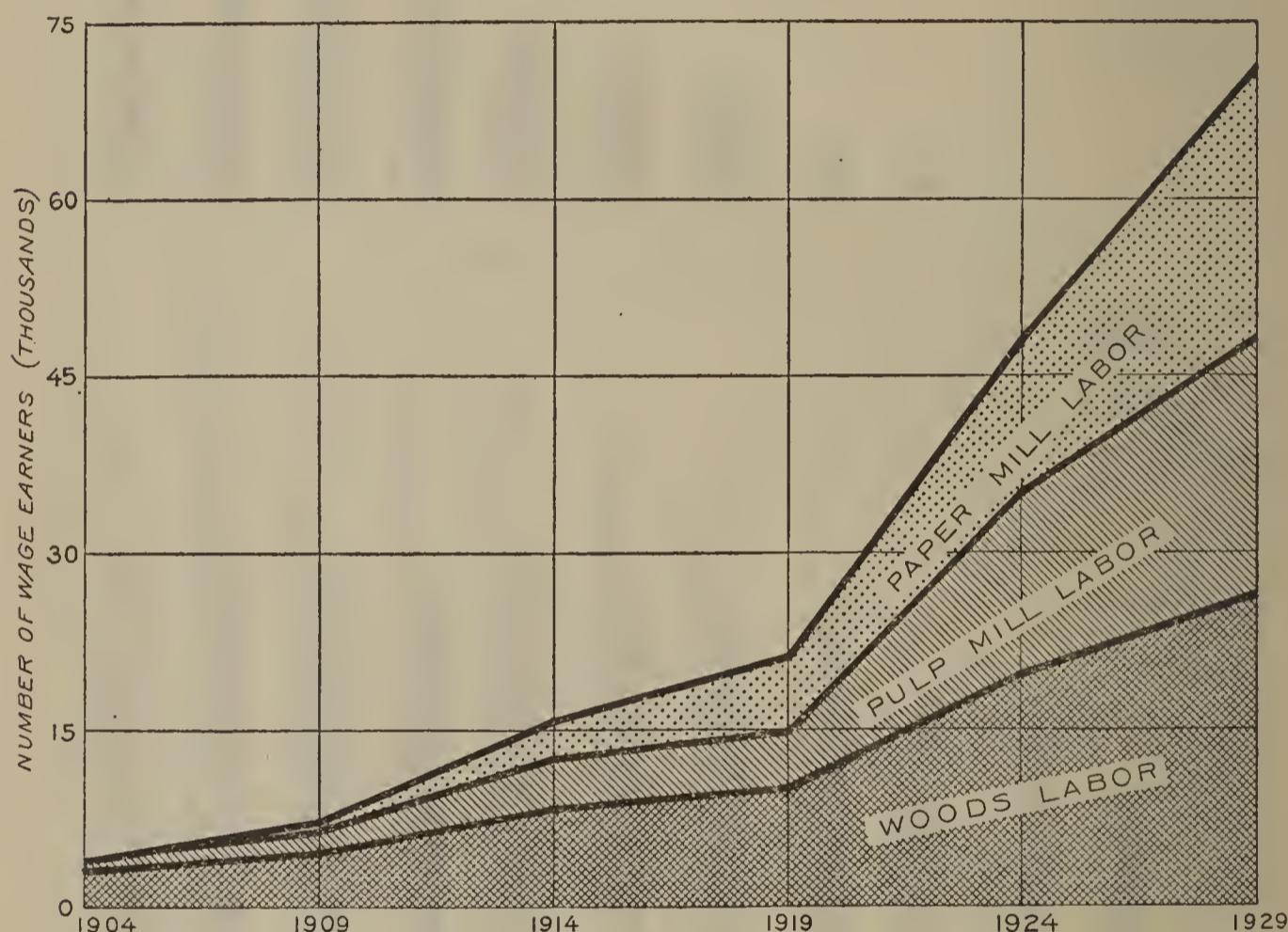


FIGURE 10.—Imports of wood, pulp, and paper converted to wage earners.

ally employed in the entire domestic industry. This import business has developed almost wholly since 1904, and most of it since 1919. The figure will increase as our paper requirements increase, unless with our domestic pulpwood resources better means are found to meet the competition of imports.

RAILROAD CROSSTIES

The number of crossties purchased during 1929 (including bridge and switch ties reduced to crosstie equivalents) amounted to 95,521,200 ties. This is the lowest for any year for which records are available from 1906 to 1929. (See table 9.)

There is considerable irregularity in the number purchased from year to year, so that it is difficult to show from the record just what the trend is, although it appears to be downward. The high figure of 1907 has not been reached since, nor does the average for the years 1923 to 1929 reach the average for the years prior to 1923. A down-

ward trend can be explained by preservative treatments and mechanical protection of ties, and by decline in railroad construction.

According to the records of the American Railway Engineering Association, the average figure for renewals on the principal railroads was 261 ties per mile for the 5-year period ending with 1915. In 1929 the 5-year average was 180 ties per mile, marking a steady decline of 31 percent. It is not improbable that this trend may continue until, possibly by 1945 or 1950, the average annual requirement for replacements is less than 125 ties per mile. Requirements for several railroads are already below that figure.

The railroad mileage in the United States has decreased since 1916, as shown in table 10, but the total track mileage, including supplementary trackage, sidings, and yards, has increased about 3,000 miles per year since 1924.

TABLE 9.—*Recorded purchase of crossties, 1906-29*

Year	Ties purchased	Year	Ties purchased
	<i>Number</i>		<i>Number</i>
1906	102,834,042	1915	121,400,000
1907	153,703,000	1923	135,976,117
1908	112,466,000	1925	111,341,759
1909	123,751,000	1927	113,708,292
1910	148,231,000	1929	95,521,201
1911	135,053,000		

TABLE 10.—*Steam railway mileage in the United States, by 2-year periods, 1900-28*¹

Year	Total miles of road	Total track mileage	2-year increases in total track mileage
1900	193,346		
1902	202,472		
1904	213,904		
1906	224,363		
1908	223,468		
1910	240,293	351,767	
1912	246,777	371,238	19,471
1914	252,105	387,208	15,970
1916	254,037	397,014	9,806
1918	253,529	402,343	5,329
1920	252,845	406,579	4,236
1922	250,413	409,359	2,780
1924	250,156	415,028	5,669
1926	249,138	421,341	6,313
1928	249,309	427,750	6,409

¹ From Interstate Commerce Commission reports.

It is impossible to say how long this rate of increase will continue, but the encroachments of automobiles, busses, and trucks upon rail business and the increasing use of trucks and busses by the railroads themselves make it very probable that new construction, together with the annual number of ties required for it, is due for an eventual or early decline.

Should tie renewals drop to 120 per mile annually by 1950, then 51 million ties will be required in that year to maintain the 1928 trackage of 427,750 miles. If the present increase of 3,000 miles

per annum should be maintained, the 66,000 additional miles by 1950 would require replacement of 8 million ties annually, and the new construction that year at 3,000 ties per mile would itself require 9 million ties, making the total requirement for the year 1950 more than 68 million ties.

FUEL WOOD

Fuel wood is next to lumber in quantity and represents some 28 percent of the total timber consumption of the United States. Fuel wood cut is estimated at over 61 million cords as of 1929. Although this is a large figure, it is considerably less than earlier estimates, as might be expected in a mechanical age.

The decline in fuel wood consumption is largely a matter of changes in requirements and competition of other materials, paralleling somewhat the changes in lumber requirements. Perhaps the first great change in domestic fuel requirements came with the introduction of the base-burner and coal. Without attempting to list all changes chronologically, there may be mentioned gasoline and gas stoves for cooking, the furnace or central heating plant using coal, oil, and gas, and electricity with electric appliances. That these changes are still under way is shown in the recent advances in distribution of gas made possible by welded pipe. There were over 40 thousand miles of natural-gas trunk lines in 1929.

Considering wood as chiefly a domestic fuel, the extent of competition of other fuels is illustrated by an increase in domestic consumers of natural gas from roughly a million in 1909 to 5 million in 1929. Domestic consumption of bituminous coal increased from 46 million tons in 1909 to 82 million tons in 1927, the latest year for which this figure is available. The domestic consumption of anthracite coal was approximately 48 million tons in 1927.

It is impossible to arrive at actual displacement of wood by other fuels from information available, but the above figures are at least suggestive. At $7\frac{1}{2}$ tons per dwelling, the domestic coal consumption of 130 million tons in 1927 would supply fuel for over 17 million dwellings, or roughly the equivalent of all urban dwellings. This coal consumption was supplemented by artificial and natural gas, fuel oil, and other minor fuels. The typical domestic consumer consumes more than one fuel; that is, there is an overlapping in number of consumers of coal, oil, gas, electricity, and wood. Furthermore, coal, oil, and gas compete with one another just as they compete with wood.

The decline in fuel wood requirements has been very largely in the urban field. And since consumption of wood for fuel is now largely confined to rural sections where its use will most likely be maintained, requirements may be approaching a minimum at current figures. The general opinion is that consumption of fuel wood has actually increased since 1929, due to present economic conditions. This may be only temporary, but it is unmistakable evidence of advantages in having a supply of fuel wood available.

NAVAL STORES

The term "Naval Stores" applies to rosin and spirits of turpentine obtained from either living trees or the resin-impregnated stumpwood and heartwood of dead trees of longleaf and slash pine of the southeastern and Gulf States. They are used in many industries for many

purposes, the distribution among uses in the United States being shown in table 11.

The naval stores produced in the United States constitute about 68 percent of the world's supply. Industries of the United States consume 55 percent of the turpentine and about 48 percent of the rosin leaving a large balance of both for export.

Table 12 shows the production of naval stores from gum (from the living tree) and from wood (stumps and heartwood) for the period 1910 to 1929, inclusive.

The requirements of industry and commerce have, until the years 1930 to 1932, when the depression has upset markets the world over, taken the total annual production without more than temporary accumulation of stocks in the primary concentration ports. While the carry-over at primary ports for the past three seasons has been and still is a serious burden on the producers of naval stores, there is small reason to doubt the orderly absorption of these surpluses when general economic conditions improve.

The relative proportion of gum naval stores and wood naval stores depends very much upon available timber for gum production.

TABLE 11.—*Percentage distribution of total turpentine and rosin consumption in various manufactures in the United States as of 1928*¹

Industry	Tur-pen-tine Percent	Rosin Percent	Industry	Tur-pen-tine Percent	Rosin Percent
Paper and paper size	0.1	36.0	Matches and woodenware		0.2
Paint and varnish	80.4	29.3	Oils and greases	0.9	(3)
Soap	(2)	16.9	Shipyard supplies	1.3	.2
Rosin oil, greases, and printing ink	.2	5.9	Vehicles	2.9	.1
Linoleum, oilcloth, and roofing	(2)	5.2	Shoe polish and leather dressing	10.9	.2
Sealing wax and insulation	1.2	3.2	Miscellaneous	.8	.4
Foundry supplies	.3	1.7	Total	100.0	100.0
Pharmaceuticals and chemicals	1.0	.7			

¹ From Gamble's International Naval Stores Year Book, 1930-31.

² Less than $\frac{1}{20}$ of 1 percent.

³ Included with rosin oil.

TABLE 12.—*Naval stores production in the United States, 1910-29*¹

Year ²	Turpentine			Rosin ³		
	Gum	Wood	Total	Gum	Wood	Total
	Thousand gallons	Thousand gallons	Thousand gallons	Thousand barrels	Thousand barrels	Thousand barrels
1910	29,750	750	30,500	1,970	14	1,984
1911	31,900	1,000	32,900	2,125	23	2,148
1912	34,000	1,200	35,200	2,267	98	2,365
1913	32,000	1,250	33,250	2,132	130	2,262
1914	27,000	576	27,576	1,706	34	1,740
1915	23,500	700	24,200	1,565	40	1,605
1916	26,750	1,000	27,750	1,782	89	1,871
1917	23,700	1,800	25,500	1,531	160	1,691
1918	17,050	1,300	18,350	1,115	123	1,238
1919	18,300	1,535	19,835	1,237	158	1,395
1920	24,450	1,750	26,200	1,577	180	1,757
1921	24,378	442	24,820	1,662	53	1,715
1922	22,395	1,859	24,254	1,500	152	1,652
1923	27,175	2,607	29,782	1,790	201	1,991
1924	26,072	3,261	29,333	1,721	258	1,979
1925	23,922	4,123	27,045	1,579	289	1,868
1926	25,500	3,983	29,483	1,700	365	2,065
1927	31,549	4,333	35,882	2,072	409	2,481
1928	28,000	4,323	32,323	1,865	432	2,297
1929	31,321	4,802	36,123	1,976	447	2,423

¹ Compiled by Bureau of Chemistry. Includes trade and association estimates.

² Crop year beginning Apr. 1.

³ Quantities given in barrels of 500 pounds.

⁴ Incomplete; does not include destructively distilled wood turpentine.

A shortage of timber for production of gum would be offset by increased production of wood naval stores, but a return to gum naval stores could be expected with recovery of timber resources.

Gallons of turpentine and barrels of rosin do not express so directly the equivalent timber requirement as do feet of lumber or cords of pulpwood. Timber requirements for naval stores can be expressed in acres better than in board feet or cords. The acreage would depend upon factors of size or trees and number of trees per acre, which vary from time to time and one locality to another. Based on typical stands at the present time, it would require more than 18 million acres of turpentine orchards to produce annually the 1929 volume of naval stores. This estimate is based upon an average production of 30 units of naval stores to the crop¹ and an average of 10 active cups per acre. Improved turpentining practice and forest management would reduce this figure by increasing the yield per crop and increasing the trees per acre.

Gum naval stores production cannot be maintained without the timber, but timber required does not constitute the forest drain in this case. A tree after being turpentined is available for lumber or other wood products. The loss in volume of wood usable as lumber is represented by the butt of the turpentined tree and is estimated at a half billion board feet measure for naval-stores production as of 1929.

MINOR WOOD PRODUCTS

Variations in the minor wood products shown in table 13, with the exception of shingles and veneer logs, have held within a rather narrow range over the past 30 years. These products not only occupy a relatively small place in total requirements, but with the exceptions noted, give no evidence of consumption trends of special significance.

Shingle production, which dropped 50 percent from 1910 to 1920, showed resistance to further loss thereafter. It is possible that the large volume of residential construction from 1923 to 1928 had something to do with this stability and that for a normal volume of construction a further decline in shingle production might be expected.

Consumption of veneer logs increased rapidly prior to 1910. There was no great change from 1910 to 1920, but consumption practically doubled from 1919 to 1929. This is due undoubtedly to a growing appreciation of the advantages of plywood and the extension of its use into new fields of construction. The prospects are for further increase in the consumption of veneer material, and because this represents an increasing demand for high-grade logs, it has considerable significance in relation to future timber requirements. The ratio of veneer logs to saw timber was roughly 1 to 100 in 1910 and 1 to 30 in 1929.

Table 13 shows little change in quantity of distillation wood consumed. There has been, however, a decline in hardwood consumption balanced by an increase in softwood. The latter is accounted for by increased production of wood turpentine and rosin, which is discussed under naval-stores requirements. Decline in consumption of hardwoods for distillation has been due to the manufacture

¹ A crop is 10,000 cups. A unit consists of 1 cask (50 gallons) of spirits turpentine and 3½ barrels of rosin.

of the same products by other processes and from other raw materials at costs that could not be met by the average wood-distillation plant.

TABLE 13.—*Consumption of wood in minor products, specified years, 1900-29*

[Forest Service in cooperation with the Bureau of the Census]

Year	Poles purchased	Shingles produced	Veneer logs (domestic)	Distillation wood	
				Pieces	Thousands board feet ¹
1900		12,102,017			
1904		14,546,551			1,049,503
1905		15,340,909	181,146		676,739
1906	3,574,666	11,858,260	329,186		1,195,130
1907	3,283,268	11,824,475	348,523		1,282,120
1908	3,249,154	12,106,483	382,542		977,844
1909	3,738,740	14,907,371	435,981		1,265,157
1910	3,870,694	12,976,362	477,479		1,450,439
1911	3,418,020	12,113,867	444,886		1,221,359
1912		12,037,685			
1914					1,042,517
1915		4,077,964	8,459,378		
1916			9,371,333		
1917			8,696,513		
1918			5,690,182		
1919			9,192,704	576,581	1,442,675
1920			6,938,854		
1921			6,843,187	400,388	482,503
1922			8,131,242		
1923		3,060,794	7,506,869	645,793	1,370,120
1924			6,862,385		
1925		3,281,514	7,324,027	720,865	1,276,245
1926			6,008,346		
1927		3,624,833	6,443,868	943,993	1,264,721
1928			5,603,690		
1929		4,556,895	6,110,672	1,095,244	1,308,323

Year	Cooperage stock					Chestnut tanning extract wood	Excelsior wood
	Tight staves	Tight heads	Slack staves	Slack heads	Hoops		
	Thousands pieces	Thousands sets	Thousands pieces	Thousands sets	Thousands pieces	Tons	Cords
1905	241,193	12,959					
1906	267,827	17,774	1,097,063	129,555	330,892		
1907	385,232	27,693	1,175,977	106,074	490,570		
1908	345,280	20,515	1,557,644	123,849	336,484		
1909	379,231	20,691	2,029,548	140,234	375,793	18,527	
1910	355,660	26,074	1,460,878	97,037	295,712		
1911	357,198	30,310	1,328,968	106,407	353,215		142,944
1918	286,401	20,711	1,099,971	60,751	332,684		
1919	353,825	24,274	1,121,324	87,381	140,772	32,526	
1921	255,047	20,505	893,621	66,747	137,380		
1923	222,507	19,342	893,682	80,477	153,954	139,107	171,077
1925	240,023	23,052	937,597	71,371	149,167	104,268	187,554
1927	324,127	26,445	961,782	59,337	134,596		178,860
1929	357,293	30,329	1,039,450	72,591	133,054	79,531	170,604

¹ Log scale.

SUMMARY

As used herein, the term "timber requirements" denotes a measure of use by consumers afforded a reasonable latitude in choice of materials, including wood. Its only tangible measure is volume of past and current consumption.

Future timber requirements cannot be definitely forecast. Sound policy-making, however, demands that they be anticipated as closely as possible. The data for basing such a program must be supplied by past experience, and the factors which have controlled or influenced trends in consumption. It is the long-time trend, rather than con-

sumption under the conditions existing since 1929, which must be the basis on which requirements are set up. This study is intended to furnish needed data rather than to give exact forecasts for the future.

LUMBER

Total lumber consumption declined from a maximum of approximately 45 billion board feet in 1906 to about 34 billion in 1929. The virtual halt in agricultural expansion since 1910 has practically eliminated a market for 4½ billion board feet of lumber annually for construction on new farms. Agricultural depression since 1921 has curtailed farm repairs and replacements to the extent of approximately 5½ billion board feet annually. This latter item of consumption may be restored when the agricultural depression lifts, giving a normal rural lumber consumption of from 10 billion to 11 billion board feet annually.

A large-scale change from single-family dwellings to multifamily housing and the intrusion of other materials in urban residential construction have caused lumber consumption in that category to lag far behind the great increase in urban building, but kept it well ahead of rural consumption. Between 1912 and 1928 there was a relative drop of 25 percent in lumber used in urban residential construction. Urban construction other than residential doubled between 1912 and 1928, but lumber consumption for this purpose remained stationary. Thus 50 percent of a former lumber use has been replaced by other materials.

There is nothing to indicate measurable expansion in the consumption of lumber for factory use or for railroad car construction. On the whole, a decline seems more likely. Lumber used in furniture increased 25 percent between 1912 and 1928 and appears to be holding its own.

After considering all factors, an estimated figure of normal lumber requirements for the Nation as at present lies between 31 and 34 billion board feet. "Normal" requirements are taken to be the volume of consumption that might logically be expected when general economic conditions are such that the Nation is conscious neither of depression nor of unusual prosperity.

Future lumber requirements depend on such factors as the restoration of agricultural prosperity, the effect of the current urban-to-farm movement on rural construction, success in meeting competition of other materials, the extent to which the all-wood house holds its place in urban construction, the rate of population increase (now estimated to cease between 1950 and 1970), and the effect of obsolescence on replacement.

PULPWOOD, PULP, AND PAPER

Paper requirements increased steadily for more than 100 years, until 1929. Whether the decline since then marks a change in the general trend cannot be determined as yet. It is reasonable to expect a saturation point in newsprint, especially in view of a declining rate of population increase, but the consumption of wood for other pulp products appears to have plenty of room to expand, particularly in the fields of fiber-board boxes and insulating materials, and for rayon and other cellulose products. Wood is the favored material for pulp and paper and should be able to hold its place against other raw materials.

The largest field for expansion of our native timber requirements lies in the possibility of substituting domestic production for the half of our consumption which is imported. The possibilities in this direction are greatly enhanced by the prospect of a continued rise in paper requirements. Total pulpwood requirements for the country amounted to nearly 13½ million cords in 1930. Estimates of probable requirements by 1950 vary from 22 million cords to 30 million cords.

FUEL WOOD

Our annual consumption of wood as fuel has shown a considerable decline from earlier estimates of more than 100,000,000 cords to a present estimate of about 61,000,000 cords. The decline has occurred largely in cities and towns. Wood has remained and is likely to remain the chief fuel in rural sections, and requirements may now be approaching a minimum for that purpose.

OTHER TIMBER PRODUCTS

Trends in minor and miscellaneous timber products do not definitely indicate any great change in total requirements from those of 1929. The most important recent increase has occurred in consumption of logs for veneer and plywood.

THE GENERAL OUTLOOK

Obviously there have been and still are so many factors at work influencing trends in the consumption of forest products that no generalization as to the future can be validated. It is impossible to reduce the net effect of opposing factors of declining and increasing use to exact estimates. However, for the consideration of both the consumer who would like to use wood and the owner of forest land who seeks a profitable outlet for his timber crop, it is well to revert to the introductory statement wherein it is pointed out that the consumption of wood is, in general, likely to vary with the abundance, suitability, and cheapness of its supply.

Mention must also be made of the fact that manufacturing and merchandising of lumber and other forest products, with the exception of paper, have changed little during the past 30 years during which time science and invention have wrought momentous changes in nearly every other field of industry. Hence, it is reasonable to feel that modern scientific methods applied to promoting the use of forest products, whether in present forms or something entirely different, would increase consumption much as in the case of other materials. Measures by which this can and may be accomplished are discussed in the section, "Enlarging the Consumption of Forest Products."

And, finally the timber requirements of a nation are measured as well by the need for industry as by the need for the products of industry. The conversion of timber into tables and chairs, let us say, is the basis for a large industry, employing thousands of wage earners to satisfy the market for tables and chairs. But it is not only our need for tables and chairs, but the employment of labor to manufacture them, that measures the importance of the industry and therefore of the raw materials necessary to maintain the industry.

If we did not need tables and chairs, we should need to find other uses for the timber in order to support an equivalent industry. That should be our objective in any case, since timberlands constitute one of our major resources, and national welfare depends upon the use we make of our resources. It would be unfortunate if requirements were to be accepted as the minimum amount of timber necessary to maintain a present limited concept of industry, neglecting requirements for expansion of forest industry as a prime factor in land use and employment of labor.