A SURVEY OF THE CAPABILITIES OF THE LAKE STATES' FORESTS TO SUPPORT AN EXPANDING PULP AND PAPER INDUSTRY

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Harold E. Christen

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By

Harold E. Christen

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DISSERTATION ABSTRACT

A SURVEY THE CAPABILITIES OF THE LAKE STATES' FORESTS TO SUPPORT AN EXPANDING PULP AND PAPER INDUSTRY

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The survey involved the analysis of available data relative to the present and future consumption and supply of the products of the pulp and paper industry in the World, the United States and the Lake States. The analysis was made in an effort to evaluate the capabilities of the Lake States to continue to provide their share of the paper and paperboard products of the nation and to expand that share in the future.

The Lake States region appears to be in a favorable position relative to the factors considered to be of importance to the pulp and paper industry. Wood, chemicals, water, labor, transportation, markets, power, and equipment are all readily available. Despite

this, the region's share of the national paper and paperboard market continues to decrease.

The region is presently growing more wood than its forest industries consume, and more than the predicted consumption in 1975. With an intensification of management practices on the forest lands of the area, future growth can be much greater than the anticipated consumption in the year 2000.

The present net annual growth within the region is estimated as 1.18 billion cubic feet. The present allowable cut has been set at approximately 64% of the net annual growth. The regional forest industries are currently using only 60% of the allowable cut.

Expansion within the pulp and paper industry will have to take place in those areas where the greatest wood surpluses occur, and consist of plants capable of using those species making up the excess. Seventy-three per cent of the net annual growth is currently composed of hardwoods, while the pulp and paper industry utilizes only 48% hardwoods in its processes. Expansion must therefore be in the form of plants capable of using hardwoods.

The growing dependence of the regional pulp and paper industry upon raw materials from public lands might be considered an unfavorable situation, due to the fact that pressures may be brought to bear upon public administrators to modify their cutting practices or to remove large areas of their forests from commercial use entirely. Dependence upon public lands as a source of pulpwood may also be considered as a favorable factor, for the ownership is stable, in

fairly large blocks and is being administered with the goal of increasing the intensity of management.

The region appears to be in a fortunate position relative to pulpwood prices, as the rate of increase in the cost of the principal regional species has not been as rapid as that of wood in some other regions. Stumpage extracts a relatively low percentage of the delivered cost of wood, but logging appears to extract too great a share. It is within this phase of pulpwood procurement that the greatest cost reductions seem possible.

The practice of intensive forestry upon the lands in the Lake States dedicated to timber production can result in an expansion of the forest industries leading to new and enlarged payrolls, greater employment opportunities and improved income for retail, wholesale, and service industries in the area.

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I. INTRODUCTION

It has been stated by Glesinger that:

> The world stands upon the threshold of developments in the use of wood as revolutionary as the invention of the steam engine or the introduction of technology to the farm. The end of World War II may mark the beginning of a new age in the application of science to human welfare. Capable of meeting the urgent needs of populations far more effectively than hitherto, and of making a substantial contribution toward improved standards of living, the world's forests and the raw materials that they yield could become one of the most significant features of that new age. As the first of the forest industries to respond to the impact of modern technology, the pulp and paper industry presents a nice illustration of what is in store for the world as the Age of Wood gets underway. Starting out using wood pulp as a medium-priced substitute for rags in the production of paper products, the industry has developed its uses to the point where today an increasing portion of the forest crop is being converted into a variety of low-priced bulk products of which paper is but one.[1]

Glesinger's quotation points out the tremendous potential of the paper industry as a whole. It is the purpose of this study to investigate the potential of the industry within the Lake States Region of the United States.

Because the present industry is based upon a heavy investment in machinery and other capital goods, it is necessary in such an investigation to examine not only the present demand for paper products but also the probable demand over a protracted period in the future. However, a study of demand alone is insufficient, and this is especially

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[1] Egon Glesinger, The Coming Age of Wood (New York: Simon & Schuster, 1949).

true of the pulp and paper industry whose present existence and future expansion are predicated to a great extent upon the supply of a large, sustained volume of raw materials, of which the most important is wood. Industry decisions relative to the estimated capabilities of any particular area to provide its raw materials must of necessity be long range, for the day of a steady supply of wood is past and the necessary timber must now come from lands dedicated to growing it. Since the growing process in many parts of the United States is a slow one, decisions made today relative to providing future raw material supply may not be felt in the market place for a full generation.

The problem of attempting to balance supply and demand regionally is further complicated by the fact that, in general, the industry is governed by the law of decreasing costs within its manufacturing phase, while an increasing cost situation prevails in the phase dealing with the acquisition of raw materials. The urge to decrease costs of manufacture by taking advantage of economies of scale has often led to an excess of productive capacity within the industry. This invites the question of why an industry invests substantial amounts of money in productive capacity when it is not selling all it can produce at present. Mr. Karl Bendetsen, President of Champion Paper and Fibre Company provided the answer in 1960 in his "Annual Report to Champion's" when he stated:

> We must prepare <u>now</u> if we are to hold our own in the markets of the future. The time lag between the decision to build a new paper machine and the day of settled dependable production is a long one--five years in many cases. This requires extensive forward planning, particularly since the paper industry's capital investment per sales' dollar is the

highest of all manufacturing industries.[1]

What holds true for a single corporation within the trade is magnified many times when the entire industry is considered within a region. Forward planning then becomes of extreme importance if the industry within the region is to hold or expand its position nationally or internationally. Interregional competition is intense, and forward planning aimed at utilizing to a maximum the factors which enhance the competitive position of a region must be carried out if the industry within it is to grow and prosper.

Present Status of the Industry in the Lake States

It is not possible to analyse a regional segment of an industry in order to chart its course for a relatively long period in the future, without investigating its past. Past trends are often indicative of future policies, particularly in cases in which complacency may have replaced progressiveness and imagination. Despite a nationwide record of tremendous expansion, the pulp and paper industry in the Lake States has grown relatively slowly in the past 30 years. Industry expansion has been hindered by a dependence upon spruce and fir until recently.

The first expansion in the pulp and paper field within the Lake States region took place about 1890, and for a period of 25 years growth was rapid. However, after World War I, the expansion slowed down, primarily because of a shortage of spruce which was the primary source of fibre.

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[1]Karl Bendetsen, "Annual Report to Champions," The Log Champion Paper and Fibre Co., Vol. XLIII, No. 7 (July, 1960), p. 6.

As late as 1921, the Lake States region accounted for as much as 25% of the entire woodpulp production of the United States and 22% of the paper and paperboard. Although the region's production of woodpulp continues to increase, its share of the national total persists in decreasing. Following World War II in 1945, the portion of the nation's woodpulp production attributable to Lake States' mills was about 14%; by 1950 it had dropped to 12%, and in the period 1955-1959 it fluctuated around the 11% mark. By 1959, the region produced only 14.4% of the nation's paper and board.

Fairly consistent figures on other phases of the industry's operations indicate the same trend. Data collected by Resources for the Future show that the region used 9% of the water, hired 10.7% of the employees, and contributed 10.2% of the dollars-added-value of the national pulp and paper industry. Estimates for 1959 indicate that in all three categories the percentages will decrease.[1]

In 1960, the region had 11.0% of the wood-pulp-producing capacity of the nation, representing little relative change since 1950. The Lake States had approximately 14½% of the paper and board manufacturing capabilities, and this, too, has shown little relative change in the past decade.

Despite the comparative loss in position nationally, the more than 460 establishments of the industry occupy an economically important place within the region. In 1959, it was estimated that over 66,000 productive

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[1]U. S. Congress, Senate, Select Committee on National Water Resources, Future Water Requirements of Principal Water-Using Industries, 86th Congress, 2nd Session, 1960, p. 59.

employees, nearly 5% of the Lake States manufacturing labor force, were engaged in the manufacture of pulp, paper and board products within the region. These workers earned over $300 million. Workers and their dependents whose livelihood at present depends directly upon the pulp, paper and board industry total over 300,000 people.[1] Many more, relatively unskilled workers, an estimated 25,000, worked part-time in the harvesting and hauling of the 3,000,000 cords of locally-produced pulpwood used by the industry in 1959. They were paid an estimated $30 million. These 25,000 woods workers are as essential to the industry as the 66,000 mill workers. In most cases they are not employees of the industry, but they have played a tremendous part in the development of the industry in the region. The pulpwood consumed is valued by the industry at $75 million, delivered at the mill, and it returned to the landowners a value assessed at $8 million. Landowners in the region also benefitted by being able to remove small and low-value trees from their woodlands at a profit, thereby placing their property in a more productive condition.

The industry provides further economic and social benefits to the region in the form of taxes and of community guidance and leadership. Purchase and consumption of supplies not utilized directly in the manufacturing processes provide additional economic stimulus. Assistance of this type is difficult to evaluate, yet it has doubtlessly played an important role in the development of the region.

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[1] American Paper and Pulp Association. A Study of Community Dependency on the Paper and Pulp Industry (New York: 1953), p. 3.

Measured in terms of growth since the end of World War II, the industry ranks first nationally within the non-durable goods field.[1]

Factors Affecting the Competitive Position of the Region

The pulp and paper industry is not uniformly distributed throughout the country. Areas that originally had plentiful supplies of raw materials became centers of production. Once the industry was well established in an area a determined effort was made to maintain the region's position nationally. The Lake States is one of these areas, for it has always been a paper exporting region.

In order to maintain a dominant position in the industry, any region must exploit its advantages, and the Lake States area has many of these. It has been stated that the industry is constituted basically upon a foundation of wood, water, and chemicals, but Stevenson lists several additional factors of extreme importance. Supplementary elements to take into consideration include: transportation costs, availability and cost of power, volume and cost of usable labor, and location with respect to consuming markets.[2]

It is important to examine the status of the Lake States region in respect to each of the factors enumerated above, for as Perloff so clearly states:

> A realistic appraisal of a region's relative advantages and disadvantages with regard to input-output access

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[1]Smith Barney & Co., The Paper Industry, A Study (New York: 1956).

[2]Louis Tillotson Stevenson, The Background and Economics of American Papermaking (New York: Harper & Brothers, 1940), p. 8.

is an essential starting point for an understanding of its growth potential.[1]

The principal factors governing the growth potential of a region in the pulp, paper, and board field are analysed below:

WOOD

With over 53 million acres of commercial forest land,[2] of which over 22 million fall within the sawtimber and pole-timber classes, and an additional 15 million within the well-stocked sapling-stand-class, it appears at first glance that the wood needs of the industry could easily be filled from local sources. The regional statistics for 1953 indicate a growing stock[3] of over 315 million cords on the commercial forest land of the area. On the surface, this appears adequate to support the present industries and take care of modest future expansion. However, a more critical appraisal shows that of the available volume only 26% is in the softwood species, while 74% is made up of hardwoods. This abnormal species-distribution is even more obvious when it becomes apparent that 42% of the hardwood volume is included in the hard-hardwood category.[4] Indications are that even though there appears to be a readily available supply of wood, much of the volume occurs in species which are at present in small demand.

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[1]Harry S. Perloff, et al., Regions, Resources, and Economic Growth (Baltimore: The Johns Hopkins Press, 1960), p. 105.

[2]*Forest land that is producing, or physically capable of producing, usable crops of wood, is economically available now or prospectively, and is not withdrawn from timber utilization.*

[3]*Net volume of live sawtimber and pole-timber trees from stump to a minimum 4-inch top diameter inside bark.*

[4]*Mixed oaks, yellow birch, sugar maple, beech, and others.*

An additional 63 million cubic feet of available volume occurs in the form of logging residue,[1] and 4½ million in unused coarse plant residue.[2] A high percentage of this volume, too, falls within the hardwood component. In respect to price, except for spruce, the softwood species are competitive with other producing areas, while the hardwoods, both in delivered and stumpage prices are currently below some other regions.

WATER

Nationwide, the pulp and paper industry ranks third among the heavy water-using industries, placing behind iron and steel and chemicals. In 1959, the industry used 2,140 billion gallons, or over 5.8 billion gallons per day.[3] Over 96% of this volume was used by the primary pulp and paper mills.

Within the Lake States Region, the industry ranked, as it did nationally, behind steel and chemicals in water use, with an intake in 1959 of 156 billion gallons. This was a daily use of over .4 billion gallons, or more than 7% of the national volume.[4] Even though this is a sizeable intake, the available supply of fresh water within the area

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[1]Cubic volume of trees cut or killed by logging and not converted to timber products.

[2]Slabs, edgings, trimmings, miscuts, veneer cores, and other material generally suitable for chipping.

[3]Select Committee on National Water Resources, Water Resources Activities in the United States, 1960, p. 8.

[4]Ibid., p. 25.

seems more than adequate. The 1958 Census estimates that there are 60,000 square miles of water within the region, of which almost 7,000 square miles is permanent inland water surface. This resource is well distributed, and maintained by an average annual precipitation of over 28 inches.[1]

Despite the fact that the region has a plentiful supply of water for industrial expansion, one obstacle to its use soon becomes apparent. Each of the states within the area has a statute relative to stream pollution. Increased pressure exerted on the industry by rigid enforcement of these statutes has led, in the past, to greatly expanded costs which have in some cases influenced the ability of the plants affected to remain competitive. This cost squeeze has been felt particularly by the sulphite industry.[2]

CHEMICALS

The pulp and paper industry is one of the larger users of chemicals, and it is estimated that for the chemical pulping processes, the cost of this component makes up 15% to 25% of the total cost of the woodpulp produced. In 1954, the industry, as a whole, used nearly 2 million tons of chemicals, valued at approximately $85 million.[3] These figures indicate that the region's share would be at least $8 million.

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[1]Michigan Economic Development Commission, Michigan Facts (Lansing: 1959).

[2]Stanton W. Mead, "Outlook for Stream Improvement in Wisconsin," Nekoosa News (May, 1957), p. 4.

[3]U. S., Bureau of the Census, Census of Manufacturing: 1954.

The Census of 1954 estimated that 775 chemical establishments were doing business within the Lake States area, and nearly all of the major corporations were represented. Authoritative sources consider that a sufficient supply of the chemicals needed in pulp and paper manufacture is present in the vicinity of the current plants, and that the needs of future expansion within the industry could also be handled locally.

TRANSPORTATION

Transportation constitutes an important cost to the industry in respect to both raw materials and the finished products. It has been estimated that this factor comprises a significant proportion of the value of paper, making up from 10% to 15% of the delivered price.

The region appears to be in a fortunate position relative to transportation of all types. Thirty-one railroads, with over 21,000 miles of track, served it in 1954.[1] Despite the fact that relatively less pulpwood is being hauled by railroads today than in the past, there is still a large volume of wood and finished products which moves by this medium. In 1947, over 3 million tons of pulpwood originated or terminated on railroads operating in the three Lake States.[2]

The region is well covered by a network of federal, state, and local highways. In 1956, it was estimated that 328,600 miles of roads, of which 241,500 were surfaced, traversed the area. This provided 1-3/4

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[1] U. S., Interstate Commerce Commission, Annual Report of Statistics of Railroads of the United States, 1956.

[2] U. S., Interstate Commerce Commission, Bureau of Transportation Economics and Statistics, Quarterly Report, 1948.

miles of road, or 1¼ miles of surfaced road, for each square mile of land area within the three states.

A shoreline, estimated to be in excess of 4,200 miles, provides ready deep-water access to most of the region, if some system of transportation using waterways is to be utilized. With the opening of the St. Lawrence waterway, a convenient route is provided for export products as well as those sold to domestic outlets.

LABOR

Although the amount of labor used in the primary manufacturing plants of the industry has been diminishing steadily, when computed on a per-ton output basis, labor costs are still an important segment of the total cost of production. Various estimates place the direct labor costs of manufacture at 12% to 25% of the total costs, but 40% to 50% of this total cost is for raw materials, and a large proportion of this is a labor cost. In fact, in the production of pulpwood nearly 50% of the cost is assessed to labor.

In 1958, it was estimated that the tri-state population was in excess of 15 million, and that approximately 4 million people were a part of the male labor force.[1] The quality of this labor force is considered to be exceptionally high and well qualified for employment in either plant or woods operation. This is an important consideration because labor is far from a homogeneous factor of production, and the

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[1] U. S., Bureau of the Census, Current Population Reports, 1958.

individuals included within this category vary according to age, sex, marital status, mobility, and degree and type of training. Employment in the mill would probably be a full-time job, while the utilization of labor for woods-work might, in many cases, prove to be only a part-time occupation. The latter situation could be advantageously adapted to the use of people engaged in some other activities, such as farming or mining, which are often part-time endeavors.

In contemplating the available labor supply for the procurement of wood, consideration must be given to the use of part-time workers. In an investigation of the problems of the independent logging and sawmill business in the Lake States by a United States Senate Committee, some interesting facts relative to this source of manpower were divulged. It was stated that:

> Much woods work is done in the off-season of farm work, and provides an important source of cash income for many part-time farmers. Farming in many parts of the Lake States is a marginal enterprise and work in the woods is usually needed to supplement family income . . . . Fortunately for the wood-using industries, there has been little alternative employment opportunity in remote areas. Woods work offers the only employment near home for most residents.[1]

It was found that the miners of the region, who often worked a short week, also provided a source of part-time labor.

To conterbalance this seemingly more-than-adequate labor supply situation, the Senate Committee injects a note of caution to the effect that for the Lake States pulpwood region during the period 1946-1950

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[1] U. S. Congress, Senate, Select Committee on Small Business, The Small Independent Firm's Role in the Forest Products Industry, 86th Cong., 1st Sess., 1959, Report 240, p. 16.

the following situation existed:

> With little industrial expansion, and farming still a marginal endeavor, labor needs were supplied without any serious wood shortages. It is questionable, however, how long this situation could continue in the face of alternative employment opportunities.[1]

This word of warning should point up the fact that adequate supplies of labor for an industry can often disappear if alternative opportunities for work are provided, and that once lost they are difficult to retrieve. James G. Yoho in his discussion of labor in the Southeast pinpoints the problem in these words:

> An important source of woods labor to the forest industries has been the agricultural sector of the economy. . . . However, this source is likely to dry up at an increasing rate in the future, particularly since a high proportion of the outward shift to date has come from the younger age groups. Ultimately, perhaps by 1980, forestry will have to look elsewhere for its major source of labor.[2]

MARKETS

The region is very favorably located with respect to markets. The 1960 Census estimates that there are over 15 million people living in the tri-state locale. This locates 8½% of the entire national population in the local area. An additional 27 million inhabitants are included in the adjacent states of Ohio, Indiana, Illinois, and Iowa, making a total of over 42 million potential paper and board consumers within overnight

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[1] Ibid., p. 75.

[2] James G. Yoho, "The Southeastern Forest Economy--Its Orientation in the Future," Forestry Newsletter, Southeastern Section, S.A.F., No. 1 (March, 1961), p. 22.

shipping distance of the region. This is 23½% of the population of the nation.[1]

The rate of increase in population over the past decade indicates that the area is continuing to grow as a consuming market. The tri-state population increased 26½%, while the "adjacent territory" expanded 18% during the period 1950 to 1960. The regional growth-rate was well above the national average, while the increase for the combined areas was equal to it. Resources for the Future, Inc., estimates a population for the Lakes States, and those states adjacent to it, of 65 million by 1980 and 80 million by the year 2000.

POWER

The pulp and paper industry is a heavy user of power, and the availability of adequate, low-cost energy is an important advantage to a region. In 1955, the industry as a whole used 30 billion kilowatt hours of electric power, and was the third largest industrial user of electric energy in the country.

The region seems to be well provided with sources of energy. In 1956, it was estimated that the tri-state area had developed over a million kilowatts of water power, and had undeveloped an additional 900 thousand kilowatts.[2] The estimated electrical generating capacity for the region in 1956, from all sources, was placed at over 11 million kilowatts.[3]

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[1]Harry Hansen (ed.), The World Almanac and Book of Facts for 1961 (New York: New York World Telegram Corp., 1961), p. 81.

[2]The NationalIndustrial Conference Board, Inc., Economic Almanac (New York: 1956).

[3]U. S. Federal Power Commission, Annual Report, 1956.

EQUIPMENT, SUPPLIES, AND TECHNOLOGY

Capitalizing on its growth potential the industry has been expanding its capacity for paper and board production at the rate of over 1 million tons each year by the installation of new machinery and improvements. Expectations of an average future annual growth of over 1 million tons in wood-pulp capacity are prevalent. For the Lake States region, the annual expansion in wood-pulp capacity in the next 5-year period is expected to average about 100,000 tons, or about 10% of the national figure.

The region is in a fortunate position relative to pulp and paper mill equipment and supplies, and also to sources of technical knowledge. Lockwood's Directory of the Paper and Allied Trades lists 227 pulpmill equipment and supply firms doing business in the tri-state area, and many more at such nearby centers as Chicago, Cleveland, Toledo, etc.[1]

Regardless of the fact that pulpmill and papermill machinery are durable, new innovations and grade changes have made much of it obsolete within a 15-year period. New processes and the use of new raw materials in old processes have led to the obsolescence of machinery in even less time. The equipment for a mill is heavy, highly specialized and often built to order, so that the presence of local sources of supply can be a decided advantage to a region.

The presence of the Forest Products Laboratory of the U. S. Forest Service and the Pulp and Paper Institute research center within the region

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[1]Lockwood Trade Journal Co., Inc., Lockwood's Directory of the Paper and Allied Trades (New York: 1958).

makes available two excellent sources of technical assistance.

It appears that in regard to those factors considered by industrial leaders to be of major importance to the pulp, paper, and board industry, the Lake States region is advantageously situated. Now, it remains to be determined whether these advantages can be adequately exploited to foster the expansion of the industry with its attendant benefits to the region and its people.

II. CONSUMPTION OF PAPER AND PAPERBOARD PRODUCTS

If the future of a regional segment of an industry is to be charted, both the demand and supply elements must be examined. In this chapter the demand function will be scrutinized, and an attempt made to predict what it will be in the future.

Demand for the products of the pulp and paper industry for all practical purposes is derived. It depends to a large extent on changes in general business activity. A close correlation has been found between the consumption of paper and board and several indicators of the economic condition of the nation. The Timber Resource Review[1] used Gross National Product as indicative of the demand for paper products, while the Stanford Report[2] was concerned primarily with the domestic population, broken down into various segments, and Gross National Product, with particular emphasis on that portion covering disposable-income payments to individuals. The Index of Industrial Production was also considered, and many economists have discerned a very close movement between the Index of Industrial Production in the non-durable goods field and the consumption of pulp and paper products. With a

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[1]U. S. Department of Agriculture, Forest Service, Timber Resource Review (6 vols., Washington: 1955).

[2]Stanford Research Institute, America's Demand for Wood (Tacoma: 1954).

greater proportion of the output of the industry entering the building and container board fields in recent years, possibly more emphasis should now be placed upon the Index of Industrial Production in the durable goods field and also upon the amount of total new construction. Chart No. 1 indicates the relationship between G.N.P., population, and consumption of paper and board.

Regardless of which of the indicators are considered, economists, in general, are almost unanimous in predicting continuing growth for the economy of the United States over the next twenty years or longer. A continued rise in the standard of living of this nation and of the world is also anticipated. If the desires of an increasing population for an improved standard of living are to be satisfied, there must be a constant effort made, on the part of the paper industry, to expand present uses and find new uses for its products.

The pulp and paper industry is considered a <u>growth industry</u> because, during its relatively short existence, it has continued to grow at a rate faster than that of the general economy. It is a corollary then that a growth industry must be prepared to grow. Within the industry, this necessity has led to a certain amount of reserve capacity, which in turn has been responsible for the ability to meet the requirements of the consumers by providing sufficient products at a price lower than that of competing goods.

What are the economic factors which have fostered the rapid growth of the paper industry? L. T. Stevenson sums them up as follows:

1. Growth of the U. S. population.
2. Improvements in the competitive position of paper and its products by lowering relative costs.
3. Development of new products through fundamental and market research.
4. Energetic marketing of the products of the industry.[1]

All indications point to bigger markets ahead, resulting from the expected growth in size and activity of the United States economy.

Past Trends in Consumption

Wood pulp, paper, and paper board are among the most widely used manufactured commodities in the world today. Such a multitude of products are made from them that their consumption has become one of the foremost indexes of our nation's standard of living. Present day uses of paper and board cover practically every industrial and cultural activity in the United States, and the end products of the industry are absolutely essential to the American way-of-life.

Generally, wood pulp and paper consumption is classified into two large categories--paper products and paperboard. Within each category, there are many products, with the list constantly increasing as research brings forth new uses for paper. It is interesting to note that although the movement of paper and paperboard consumption has been steadily upward, this has not been the case for all grades.

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[1]L. T. Stevenson, The Significance of Growth Factors to the Paper Industry, Reprint from Paper Trade Journal (Feb. 20, 1953).

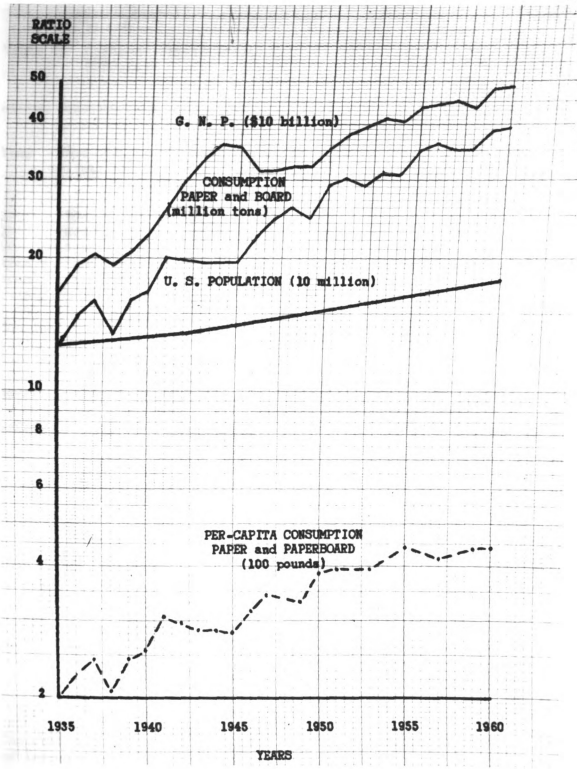

Figure 1. Rates of Change in G.N.P., Population, and Consumption of Paper and Paperboard Products - 1935 - 1960.

Table 1. Apparent annual consumption of paper by principal grades--1930-1959

Year	Paper Grades: News-print	Absorbent: Ground Wood	Absorbent: Book Fine	Absorbent: Book Coarse	Tissue: Sanitary	Building	Total Paper	Per Cap. Lbs
	(1000 tons)							
1959	7045	926	4470	3943	2083	1382	21,528	243.2
1955	6484	886	3799	3680	1761	1586	19,290	233.5
1950	5856	705	3877	3554	1358	1419	16,752	220.9
1945	3424	636	2503	2533	971	868	10,846	155.4
1940	3775	550	2534	2352	721	677	10,615	161.2
1935	3309	274	2015	1632	473	437	8,175	128.5
1930	3496	221	2250	1581	362	460	8,401	136.8
Compound Rate of Increase %								
1930-59	2.4	4.9	2.3	3.1	6.0	3.7	3.2	1.9
1950-59	1.9	2.8	1.4	1.0	4.3	Loss	2.5	1.0

Sources: Wood Pulp Statistics, U. S. Pulp Producers Assoc., Inc.
America's Demand for Wood, Stanford Research Institute.

Table 2. Apparent annual consumption of paperboard by grades--1930-1959

Year	Paperboard Grades: Container	Bending	Non-Bend.	Building	Other	Total Board	Per Cap. Lbs.
	(1000 tons)						
1959	8621	4650	1136	1899	1460	17,200	194.2
1955	7552	3931	1053	1622	1512	15,429	186.8
1950	5770	3135	876	1227	1249	12,257	161.7
1945	4093	2270	721	890	886	8,818	126.4
1940	3334	1416	899	163	329	6,141	93.1
1935	2358	1121	624	65	415	4,583	72.0
1930	1915	1013	653	108	229	3,918	63.8
Compound Rate of Increase %							
1930-59	5.1	5.2	1.9	10.0	6.4	5.1	3.8
1950-59	4.1	4.0	2.6	4.5	1.6	3.5	1.8

Sources: Wood Pulp Statistics, U. S. Pulp Producers Assoc., Inc.
America's Demand for Wood, Stanford Research Institute.

During the period 1930-1959, paper and paperboard consumption increased at a compound rate of 3.9% while Gross National Product was increasing at 3.3% and National Population at 1.2%. However, an examination of the more recent period 1950-1959 discloses a different situation. During this 10-year expanse, the use of paper and paperboard increased at only 2.9% while Gross National Product was expanding at a 3.2% rate and National Population at a 1.3% rate.

A study of the products making up paper consumption shows that during the period 1930-1959, while all grades were advancing at a 3.2% compound rate, tissue and sanitary paper-use increased at a 6.0% rate, while groundwood with a 4.9%, building paper with a 3.7% and coarse paper with a 3.1% rate, were all above the average. During this period, newsprint, fine, and book papers advanced at a rate below average. However, an examination of the more recent period, 1950-1959, shows a different trend. In the course of this decade, during which paper-use grew at only a 2.5% rate, tissue and sanitary grades with 4.3% led the field once again, with groundwood (2.8% increase) the only other category above average. Coarse paper increased at only 1.0%, newsprint at 1.9%, while building paper, above average for the long period, showed a loss.

A study of the consumption of paperboard brings to light several interesting facts. In the course of the three decades, 1930-1959, the use of all paperboard increased at a 5.1% compound rate--over 2% greater than the growth of paper products. Of the categories making up paperboard consumption, building board (at 10.0) and other miscellaneous board (at 6.4%) increased well above average, while container and bending board were average and non-bending board increased at a rate far below

average. An examination of the recent decade 1950-1959 discloses little change in the status of the various grades, but a shrinking of the rate of increase of total paperboard use to 3.5%. Despite this drop, the rate is still above the increases in Gross National Product and in paper consumption. Building board leads the field, as it did during the 3-decade period, with a rate of 4.5%, while container and bending board remained above average. However, in the category "other miscellaneous boards," the rate dropped off drastically to 1.6%. This of course could have been the result of statistical-gathering techniques, for the consumption of this class of product was computed as a residual value.

One striking feature in the movement of paper and paperboard products over the 30-year period has been the increasing proportion of the total consumption which is being appropriated by paperboard. Where in 1930 only 31.8% of the total use was in the form of paperboard, this category now, in 1959, assumes 44.5% of the total consumption, and with the continued substitution of paperboard for lumber in the packaging and construction fields, it appears that this trend will continue.

Consumption in the Future

A perusal of data relating to the national consumption of paper and board shows that there has been a virtually uninterrupted rise in their use since the employment of wood as a raw material in manufacture. This increase has occurred not only in the absolute volume being consumed, but also in the per-capita use. The fact that both absolute and per-capita uses have increased is of importance when an attempt is made to analyse the factors responsible for and correlated with the rise.

Population increase alone could account for a rise in the absolute amount consumed, but additional elements must be considered if responsibility for the per-capita increase is to be assessed. Torsten Streyffert, in his analysis of world timber trends and prospects, points out that a rise in the standard of living, caused by technical developments, is one of the most important factors responsible for increased per-capita consumption of paper and board products. He reasons that this is due to the fact that paper and board serve a number of needs associated with an increase in standard of living better than do many other products.[1] He indicates that FAO[2] has found a direct relationship between paper and board consumption and the per-capita income, indicative of standard of living, of several countries throughout the world, and has used it in a prognosis of future consumption. He further explains that the standard of living rate-of-increase probably will not be directly related to the rise in per-capita consumption of paper and board in the future because:

> . . . The per capita consumption of paper and board will be unable to maintain the same rate of increase as the per-capita national income. A rising standard of living entails, namely, that national production is represented to an increasing extent by services and the increasing value of the production, as a result of the greater degree of processing and improved quality.[3]

It can easily be seen that a number of factors affect the consumption of paper and board products, and any attempt to predict future use cannot be simplified to the point of an elementary correlation between

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[1]Torsten Streyffert, World Timber Trends and Prospects (Uppsala, Sweden: Almquist & Wiksells, 1958), p. 101.

[2]Food and Agriculture Organization of the United Nations. Rome.

[3]Ibid., p. 102.

two variables such as the standard of living and consumption. In addition to the numerous basic factors to be considered, there is a great amount of interaction among them which adds to the difficulty of isolating the effect of each individual element.

Some of the basic factors which economists consider to affect, in varying degree, the consumption of paper and board are: (1) population growth, (2) improvement in the standard of living, (3) substitution, and (4) the relative price of paper products in comparison with other materials. In regard to the latter factor, the industry finds itself in a very fortunate position at present. Because of the tremendous technical developments produced by the industry, new products of high utility have been made available to the consumer at favorable prices, when compared with those of competing materials. The question of how long this development will continue must be considered when attempting to predict future consumption. No question exists if the segments of the industry have the same philosophy that John H. Hinman, President of International Paper Company, expressed so well in 1948 when he said:

> I think that our future does not lie in any narrow conception of the uses of wood, but in the full realization that we ourselves are processors of a forest crop from which we can develop - alone or with others - a great variety of products for the good of man. Perhaps in the next half-century we will discover that paper was only the first of many such products.[1]

Beginning in 1954, with the report of the Stanford Research Institute, there have been several prognoses made of the future consumption of

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[1]John H. Hinman, "Address," Fiftieth Anniversary Dinner (New York: January 31, 1948).

forest products. A period of seven years has alapsed since two of these forecasts were made, and a lesser time since the more recent attempts. The trends predicted can now be evaluated for the relatively short period of time which has expired. Table 3 summarizes the prognoses:

Table 3. Consumption of paper and paperboard—U. S. 1959-2000.

Year	Stanford Report 1953	U.S.F.S. T.R.R. 1954	U.S.D.C. BSDA 1956	R.F.F. Median 1954	American Marietta Co. 1960	Actual
			(Million tons)			
1959						38.7
1960	37.4	*33.7	40.8		35.1[1]	39.0[2]
1965	42.7	*42.0	48.6		43.3	
1970	47.9	*48.0			52.2	
1975	53.5	58.0	60.0		64.2	
1980			75.5[1]	98[1]		
2000	N.E.	95.0	155	240		

[1]U. S. Production estimate.
[2]Preliminary estimate.
*By Graphic interpolation.
N.E. - No estimate.

From an examination of Table 3, it is evident that, for the relatively short period which has elapsed, most of the estimates of consumption are conservative. The period 1953 to 1960, however, was one which could be considered as above average in respect to national prosperity, and possibly the consumption figures indicated by the Stanford Report and the Timber Resource Review, the most conservative of the estimates, may prove to be the most nearly correct in the long run.

On the basis of these two estimates, a consumption of at least 55 million tons of paper and board can be expected by 1975. This indicates a growth in use of 16 million tons during the 15-year period.

Such a growth constitutes a compound rate of 2.3%, well below the rates of 3.9% exhibited during the period 1930-1959 and 2.9% for the period 1950-1959. If the more liberal estimates of the Business and Defense Services Administration and Resources for the Future, Inc. are used, it is expected that by 1980 the consumption of paper and board will be between 75 and 98 million tons. Using the median value of 87 million tons as indicative of the use in 1980, the compound rate of increase becomes 4.1%, which is well in excess of recent growth. Such a consumption would necessitate an increase in use of 48 million tons in a 20-year period.

Although the prognoses of Resources for the Future, Inc. and the Business and Defense Services Administration appear at this time to be ultra-liberal, it would be foolhardy to disregard them. The consumption of paper and board products has increased for various intervals in the past at a rate in excess of that predicted, and the 30-year growth rate of 3.9% is not far below the 4.1% predicted by the two agencies. However, it will take major capital investments, on the part of the industry, directed toward improving the efficiency and flexibility of its operations and toward developing new high standards of product quality and customer service, if the prognosis is to be realized.

If research to provide the consuming public with new paper products, of higher quality at a competitive price, is not pressed to the maximum the median prediction of R.F.F., Inc., for a per-capita use of over 800 pounds of paper and board by 1980 will not be realized. This places the problem of future consumption squarely in the lap of the industry, and the question of the portion of the future use to be garnered by each

section in the hands of the regional segment of the industry. (For more detailed information on the various estimates see Table 1, Appendix).

In addition to domestic consumption, the industry is becoming increasingly aware of the possibilities of the export market. This outlet can provide an avenue to take care of the products of the surplus plant capacity so necessary if new customers are to be attracted, and old users held, and a full share of the prospective growth realized.

Export of paper and board products by the United States in 1959 totaled 887,000 tons,[1] and it is expected that the market will soon reach the one-million ton mark. A market of such size assumes importance even though it constitutes only a small percentage (3%) of the domestic production. W. LeRoy Neubrech in his "Economic Review" stated:

> . . . it is anticipated that not only will the volume of trade continue to increase rapidly, but also that the movement between countries will be progressively freer of trade restrictions . . .[2]

It is evident therefore that the industry must consider world consumption as well as domestic use in the future, and make plans to capture a share of the present international market and its anticipated growth.

FAO estimated in 1954 that the world consumption of paper and board would reach 64.7 million tons by the 1960-62 period. If the Soviet Union is excluded, the predicted world use is still a large volume, 61.6 million tons.[3] If this consumption is realized, the compound rate of

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[1]U. S. Pulp Producers Association, Inc., Wood Pulp Statistics (25th Edition, New York: August, 1960), p. 114.

[2]W. LeRoy Neubrech, "Economic Review," Pulp, Paper and Board, Vol. XVL, No. 1 (March, 1960), p. 3.

[3]FAO, World Pulp and Paper Resources and Prospects (New York: 1954).

increase for the 10-year period 1950-52 to 1960-62 would be 3.2%. A recent FAO estimate anticipates a sharp rise in world consumption, predicting that 96 million tons will be used by 1965, and 146 million tons by 1975. This is a predicted growth rate of over 4% for each decade. It is difficult to make long-term estimates of future consumption for the industrially-underdeveloped areas of the world. However, as literacy increases, and a rise in per-capita national income takes place, it is logical to assume that there will be, on a percentage basis, a tremendous increase in the demand for paper and paper products. Part of this could be satisfied by the production of the industry in the United States. Evidence that the export market is receiving increasing emphasis from domestic paper companies can be gathered from the statement of Thomas B. McCabe, President, Scott Paper Company, in his annual message, in which he stated:

> We believe that rising standards of living all over the free world will continue to provide unusual opportunities for sales of household paper products.[2]

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[2] Thomas B. McCabe, "The President's Message," Scott Paper Company Annual Report (1960), p. 3.

III. DOMESTIC SUPPLY OF PAPER PRODUCTS AND WOODPULP

In general the supply of woodpulp and paper products is elastic because normally excess capacity exists within the industry, thereby making it possible to increase production in a relatively short period. However, during an era such as World War II, when for short periods over 150% of normal capacity was being used, supply becomes very inelastic. This is due to the time and financing required to increase present facilities or to add new ones.

The paper and board industry, a growth industry with a high capitalized value, has been able to supply the domestic consumers with their products for the past 30 years, and this despite the disruptions caused by the war efforts of World War II and the Korean conflict. In order to accomplish this, the industry has constantly been in the situation of having excess capacity, and it has seldom operated for a year at its maximum. For purposes of the analysis of the supply problems, paper and board products will be examined separately from woodpulp, due to the fact that an increasing percentage of the domestic production of paper and board is being made up of domestically-produced woodpulp. In 1930, only 920 pounds of domestic pulp was used for each ton of paper and board; by 1940 this had increased to 1240 pounds, while in 1959 the ratio was 1440 pounds per ton.[1]

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[1] U. S. Pulp Producers Association, Inc., 25th Edition.

As of 1959, the regional woodpulp capacity was estimated at 3.1 million tons and production was listed at 2.7 million tons, an operating rate of over 87%. In the year 1954, the region produced 2.1 million tons, but used 2.7 million tons of woodpulp in the manufacture of paper and board. These figures indicate an importation of approximately 600 thousand tons of woodpulp by the industry within the region. By 1957, this figure had risen to an estimated 800 thousand tons.[1]

The Lake States produced in 1959 14.4% of the total paper and board products manufactured in the United States, while only creating 9.8% of the woodpulp. Since 1930, the region has been producing a constantly decreasing amount of the nation's woodpulp, dropping from over 20% to below 10% during the thirty-year period. During the decade 1945-1955, the pulping capacity of the region increased 34%, while that of the United States was increasing 86%. Of the regional increase, the greatest percentage was in pulps suitable for board, heavy wrapping papers, tissue, and insulating board.

Capacity and Capacity Problems

Over the past thirty-year period, the paper and board industry has increased its woodpulp capacity from 6 million to 30 million tons in an endeavor to satisfy the demand for its products. Except for the World War II years of 1942 to 1947, the increase has been steady. This increase was at a compound rate of 5.5%, considerably in excess of the rate of

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[1]U. S. Department of Agriculture, Forest Service, Feasibility of Using Lake States Hardwoods for Newsprint and Other Pulp and Paper Products, April, 1959, p. 23.

increase in consumption (4.8%) over the same period. The rapid growth-rate of productive capacity has led to periodic capacity problems when, due to inventory adjustments, it has been necessary for the industry to operate at reduced rates, which in many cases approached the critical point below which profit would have ceased.

During the Great Depression period of the 1930's, both woodpulp and paper and board mills operated at about the 75% capacity-level, reaching their low point in 1932 at 58%[1]. This was below the breakeven point, estimated to be from 60% to 70% by various leaders in the industry. It was not until the effects of World War II were felt that production, as a percentage of rated capacity, began to increase. It was during the five-year period, 1940-45, that the percentage advanced to between 85% and 90% as annual capacity remained fairly constant at the 11 million ton mark, and production also remained constant when man-power shortages developed. Following World War II, annual expansions in domestic woodpulp capacity of 1½ to 2 million tons were common, except in the recession years of 1952-53 and 1958-59 when the increase was only in the vicinity of 600 thousand tons. Despite the earlier recession of 1952-53, the percentage-of-rated-capacity being used remained high, as production and expansion remained in line, but in 1958 the rate dropped once again, below the 80% mark, as consumption did not keep abreast of plant expansion.

Present plans for the 4-year period 1959-63 call for the addition of 2.2 million tons of woodpulp capacity, which will be at approximately the

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[1]American Paper and Pulp Association, A Guide to Career Opportunities in the Paper Industry (Beloit, Wisconsin: Beloit College, 1954), p. 22.

recession rate of 600,000 tons annually.[1] This increase, when matched against the projected increase in consumption (using the relatively low figure of the Timber Resource Review) indicates that if expansion is held to this amount, the operating rate by 1963 will be approaching the 98%-of-capacity-level. This might work a hardship on the consuming public. Such a trend could lead to greater difficulties within the industry than those caused by over-capacity. John A. Guthrie in his discussion of the elasticity of supply within the pulp and paper industry points up the problem nicely when he states:

> Normally excess capacity exists in most branches of the industry, and under these circumstances supply is very elastic. However it can be inelastic when excess capacity does not exist, because of the time required to build and equip new plants.[2]

The question now becomes one of whether a highly-capitalized growth industry, which is extremely conscious of economies of scale, can afford to find itself in a position of inelastic supply even for a relatively short period. Projections of demand indicate that additional capacity will be needed. The real problem is timing; either too soon or too late could cause difficulties.[3]

In order to protect a market which is constantly changing in both the amount and the grades demanded, it is necessary for the industry to carry large inventories of their finished products. Inventory

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[1] U. S. Pulp Producers Association, Inc., 25th Edition, p. 112.

[2] John A. Guthrie, Economics of Pulp and Paper (Pullman, Washington: State College of Washington Press, 1950), p. 110.

[3] W. LeRoy Neubrech, "Economic Review," Pulp, Paper, and Board, Volume XVI, No. 3 (September, 1960), p. 4.

adjustments take place quite often and seem to be correlated quite closely with the business cycle. They lead to a temporary slowing down of the rate of expansion within the industry, followed by an upward spurt when the inventories are reduced. "Grade shifting" within the industry and within the consumer demand often makes excess inventory depletion a difficult task, and it has led to the "dumping" of certain products in the past. In addition, within an industry where historically capacity has been deemed fully adequate, many consumers hold their inventories at low levels relative to their sales. They thereby transfer the responsibility for the maintenance of adequate stocks to the primary industry.

With the current expansion in the European economy, and with evidence of its continued growth, a budding interest has been shown on the part of the industry in the capturing of a portion of the potential export market. This could be used as a means of inventory adjustment during periods when domestic demand moderated. Whether it would be possible to hold the export market without making plans for a domestic-capacity increase to take care of it, would be the problem. It appears that if real advantage is to be taken of the export possibilities, they must be considered in the industry's plans for future expansion of productive capacity. That at least a segment of the industry is considering the export market in its expansion plans is demonstrated by the fact that the output of a new Alaskan mill, of 100 thousand tons annual capacity, is reportedly aimed at the Japanese market.[1]

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[1]John R. Mutzabaugh, "Raw-Material Trends," Pulp, Paper, and Board, Volume XVI, Number 1 (March, 1960), p. 5.

At a recent FAO conference, the world consumption of paper and board was estimated at 62 million tons in the year 1955, and the expected consumption for 1965 was set at 96 million tons. To gain a share of that projected increase would entail continued plans for the expansion of the present capacity of the industry. One element of uncertainty appears when an effort is made to estimate the portion of the long-term world market which might be claimed by the domestic industry, and that is caused by the impending creation of trade blocs in Europe and South America. It is perplexing enough to try to foresee the future within the United States, but attempting to prognosticate for the world raises many additional problems. However, the industry, if it is to remain a true growth activity and continue on its past course of rapid development, must consider supplying the world as well as the domestic market in planning for its future capacity.

IV. PRICE OF PAPER AND PAPERBOARD PRODUCTS

The future use of the products of the pulp and paper industry will be dictated to a large extent by the price at which those products can be sold, and the relationship of that price to those of competing materials.

A large share of the rapid increase in the use of paper and board products can be attributed to the research, on the part of the industry, which has led to the production of a multitude of new and improved products that have been made available to the consumer at a price below that of substitutes.

In any consideration of the price trends of paper and board products, it is well to review the technical conditions of production that substantially affect price behavior. Stevenson lists these as follows:

1. It is a "natural resource industry" and as such it is subject to the law of increasing costs. Operating to offset this is the law of decreasing costs which applies to it as a manufacturing industry.

2. The high capital investment per dollar of annual revenue results in making a high percentage of total costs fixed costs.

3. Fixity of invested capital makes it practically certain that a mill will continue to produce paper just as long as at least some part of the fixed costs are recoverable in the price.

4. The nature of papermaking as a continuous process is such that there is a tendency for management "to keep the mill moving" instead of shutting down. It is for the same reason more economical to run large orders than small ones.

5. Technical improvements in machinery and processes have undoubtedly influenced the trend in prices in many branches of papermaking.

6. Probably one of the most important influences upon price behavior in the paper industry is "grade shifting." It acts as a brake upon run-away prices in a particular line, and is a factor that all manufacturers are obliged to consider when establishing prices.[1]

Regarding the first of the technical conditions, it is interesting to consider the statement relative to the industry being subject to increasing costs because it is a "natural resource industry." It appears that, by means of the practice of intensive forestry upon lands relatively close to the mills, the cost of wood could be kept from constantly increasing. Then, too, innovations in harvesting and transportation could go a long way toward stabilizing or possible lowering the cost of that important raw material. A. Koroleff in his discussion of stability as a factor in efficient forest management made the following statement:

> Areas under intensive forest management, with good permanent labor and continuous operation will produce, in continuity,much more wood at low cost than can be expected under practices prevailing in many places today.[2]

The recent tremendous advances made in the use of inferior species, and woods and plant residues have also aided in preventing run-away raw-material prices. Although wood is considered the most important and adaptable raw material for paper and board manufacture, it is not indispensible. Its price will be held in line, in the long run, by the

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[1]Stevenson, The Background and Economics of American Papermaking, p. 150.

[2]A. Koroleff, et al., Stability as a Factor in Efficient Forest Management (Montreal: 1951), p. 290.

availability of substitutes such as waste paper, the cereal plants, and others. The fact that pulpwood and wood pulp are duty-free in the United States makes the market for these raw materials an international one, and this should tend to keep prices of the domestic products in line.

The recent publication of the Timber Resource Review, which indicated that for the supply of bulk-wood products no emergency existed nationally, and that in fact, a surprisingly sound situation prevailed, succeeded in dispelling to some extent the conservation propaganda upon which forestry was based for many years. New and liberal thinking concerning the need to use wood should aid immeasurably in placing a ceiling on the cost of raw materials to the industry in the future.

The second half of the first statement, relative to the decreasing cost of the manufacturing phase of the industry, is well borne out by a close examination of the trends within it. The past two decades have seen a constant increase in the size of individual plants within the primary manufacturing stage, and a rapid vertical integration within the industry. To date, no maximum seems to have been reached relative to the size of the plant needed to derive the minimum cost of manufacture. That such a maximum exists and will eventually be reached is obvious, and it appears that it will be at some point where the rising costs of acquiring increasing amounts of raw materials are greater than the decreasing costs due to economies of scale in manufacturing.

The second, third, and fourth conditions originate from the fact that, due to the high capital investment involved in the plants, a great part of the costs of manufacture within the industry fall into the "fixed" category. All true fixed costs when spread against volume

produced will decrease on a per-unit basis as production is increased.[1] This factor of high-fixed investment has forced the industry to increase the size of its plants and the speed of its machines, and to strive to attain continuous operation at a high percentage of rated capacity. Even in periods of recession, the industry tends to operate as long as at least part of the fixed costs are being met. This situation has led to periodic overproduction and inventory accumulation, which in turn has tended to keep prices of the products in line. Continued striving on the part of the industry to minimize its costs by taking advantage of economies of scale bodes well for prices to future consumers of paper products. The O.E.E.C. in its analysis of the pulp and paper industry in the U.S.A. spotlighted this situation when it stated:

> A heavy investment in machines is the main factor increasing labor efficiency in the paper industry . . . Records show that increased productivity due to large capital investment has been shared by paper mills with workers (higher real wages) and with consumers (lower prices).[2]

Probably no other industry has exceeded the paper and board industry in the matter of technical improvements in machinery and processes conceived during the past two decades. The advent of the semi-chemical and chemi-groundwood processes, and their adaptability to the use of hardwoods, has been responsible, to a large extent, for keeping the real price of paper and board products constant. In addition, the formulation of the many new uses for materials made from wood pulp has greatly expanded the

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[1]Donald Maxwell Matthews, Cost Control in the Logging Industry (New York: McGraw-Hill Book Co., Inc., 1942), p. 11.

[2]Organization of European Economic Cooperation, The Pulp and Paper Industry in the U.S.A. (Paris: 1951).

consumption of such materials, and contributed to the benefits which the industry derived from economies of scale. The Stanford Report in its consideration of the future price of pulp products stated:

> Furthermore, opportunities for further technological improvements in pulp manufacturing processes, increasing use of high-yield pulp processes, the availability of economic mill sites, and the more widespread use of wood now poorly utilized or wasted, will tend to allow increased pulp output without increasing the price faster than the general level of prices.[1]

The effect of "grade shifting" within the industry is difficult to analyse. However, it is known that it is constantly taking place, as certain firms make an effort to manufacture products which at that particular time appear to be more apt to lead to a profit. This process tends to prevent prices for any particular segment of the industry's output from getting out of line. It leads to an increase in the elasticity of supply within grades, even though it has no effect upon the overall elasticity for the entire industry's output. Many older mills, particularly those in the more economically mature sections of the country, are constantly "grade shifting" their production in search of more profitable products. The shift in such cases is usually toward the finer, higher-priced grades whose profitable production often depends upon craftsmanship rather than upon the speed of machines and economies of scale, and in which the raw materials make up a relatively small fraction of the entire cost.

In addition to the technical conditions of production which affect the price of the products of the paper and board industry, one of the

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[1]Stanford Research Institute, p. 36.

most important factors is the price and quality of substitutes. For some paper products there are no adequate substitutes at present, and the demand for them consequently is inelastic, but for much of the output of the industry adequate substitutes are available and demand is more elastic and price is affected accordingly. For such items as newsprint, writing paper, and book paper there are practically no substitutes, and the only competition is indirect, in the form of other mass-information media such as radio and television. However, the products used in packaging are open to substitution by lumber, glass, polyethylene, textiles, metals, and plastics and must meet stiff competition from them. The products used in the building trade are directly competitive with lumber, plastics, plaster, and brick and tile, while specialty items such as tissue and sanitary papers receive some competition from the textiles.

The ultimate balance between supply and demand for paper and board products will be governed by price, because, within wide ranges and in the long run, price will influence the substitution of the industry's products by other materials and vice versa. It is of extreme importance to the industry and to the consumer that the price of paper and board products should not be so costly that consumption is seriously restricted.

Inspection of Chart 2 indicates the price of paperboard, in the period 1951 to 1938, has remained constant while the rate of increase in the price of competing construction materials (structural steel and brick and tile) has been increasing. However, it is interesting to note that during the same period one competitor, lumber, also shows a constant price situation. This is surprising when the fact is considered that during the period 1930 to 1950 lumber showed the greatest rate of increase

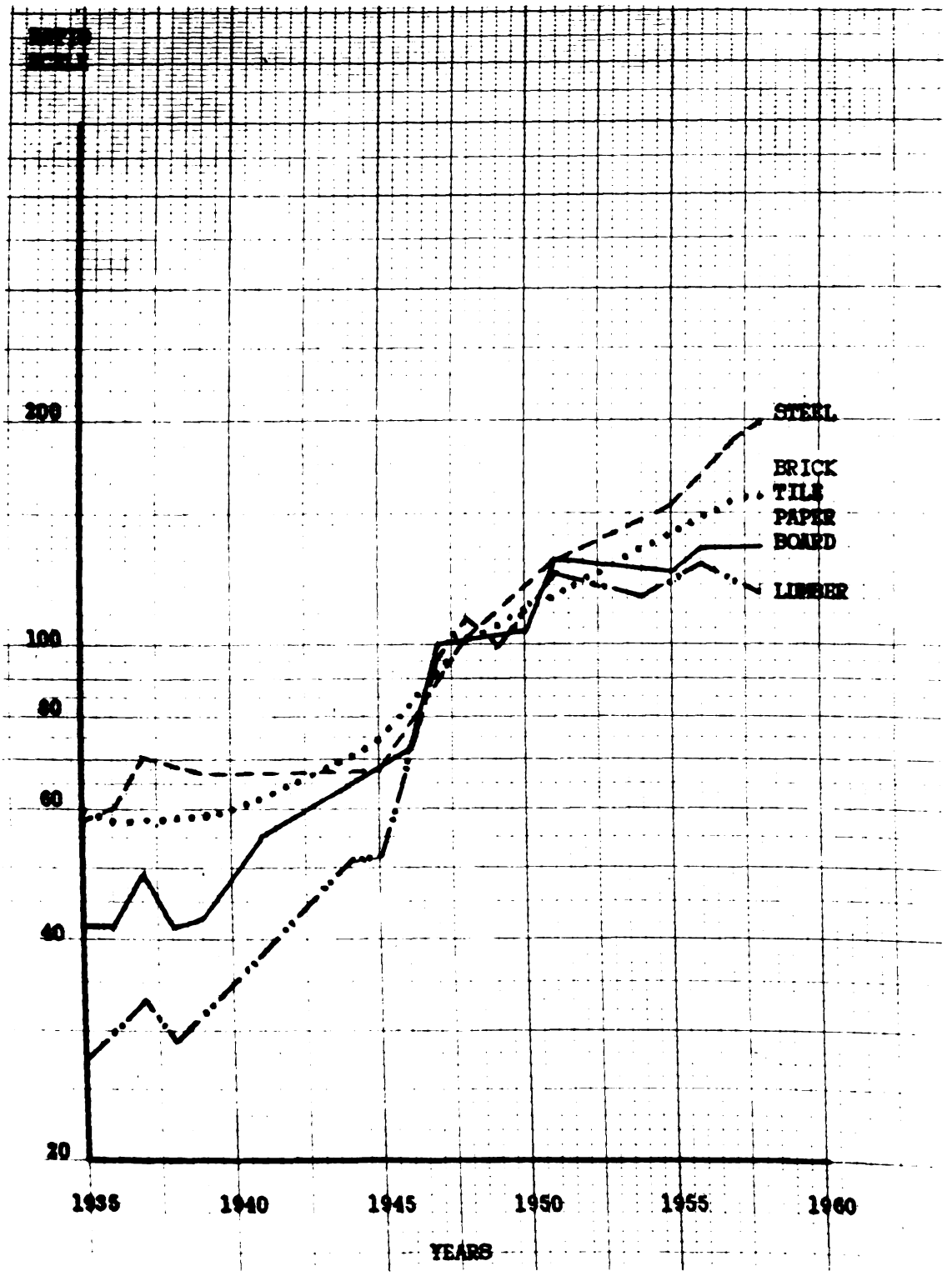

Figure 2. Rates of Change in Wholesale Price Indexes for Construction Materials - 1935 - 1960.

in price of any of the construction materials.

An inspection of Table 4 reveals the relationship of the wholesale prices of paper and board and woodpulp to "all commodities." For a more complete comparison with selected construction materials see Table 2 in the Appendix.

Table 4. Wholesale price indexes for newsprint, paper, paperboard, woodpulp, and all commodities 1940-1958. (1947-49 = 100)

Year	Commodities				
	Newsprint	Paper	Board	Woodpulp	All Commod.
1940	52.8	NA	48.6	50.7	51.1
1945	63.6	NA	64.6	63.5	68.8
1950	106.2	106.5	105.0	95.6	103.1
1955	131.6	129.3	127.1	112.9	110.7
1958	140.6	142.8	136.2	121.2	119.2

Source: Bureau of Labor Statistics, Wholesale Prices and Price Indexes, p. 26.

It appears that continued progress can be expected in the reduction of all costs within the industry, and this should be sufficient to permit paper and board products to be supplied to the consuming public, in the future, at prices bearing about the same relationship to the prices of competing products.

The reduction of the costs of distribution of the products of the industry is a really important consideration to the firms within it. During the period 1950-1955, many of the companies made changes in their sales distribution programs and enlarged their operations, not only in the

domestic market but for the first time in selected foreign markets.[1]

In regard to the development of the Lake States segment of the pulp and paper industry, it is well to remember the fundamentals which, to a large extent, determine regional economic growth, and to observe that they deal primarily with competitive costs. Harry S. Perloff lists the factors as:

1. The relative cost of production (Materials and labor).
2. The relative size of different marketing centers.
3. The relative transportation costs.[2]

He suggests that the economic growth of a region is directly related to:

1. Its access at competitive costs to inputs of production.
2. Its access at competitive costs to markets for its products.[3]

It appears, therefore, that if the Lake States region is to grow in the pulp, paper, and board field, it must remain competitive in its production and distribution costs so that the prices of its products can compete on the open market not only with substitutes, but also with the same products from other regions.

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[1]W. Leroy Neubrech, "Economic Review," Pulp, Paper, and Board (March, 1955), p. 5.

[2]Perloff, et al., p. 56.

[3]Ibid., p. 75.

V. DEMAND FOR PULPWOOD

The demand for pulpwood is a derived function which depends upon the needs of consumers for paper, paperboard, and other pulp products. These needs change over time due to changes in population and in the level of economic activity of the nation and the world. Derived demands are generally comparatively inelastic, and therefore the amount of the product consumed is relatively unresponsive to price changes, particularly in the short run. In the long run, however, raw materials which can be substituted for pulpwood would be utilized if the price of wood was to rise materially.

That paper and board can be and are manufactured from materials other than wood is well known. Therefore, the possibility exists that if the supply price of pulpwood increases sufficiently, substitutes will be used. In the short run, however, substitution would be unlikely because it would entail changes in production and procurement methods of sufficient stature to make it inadvisable. However, should management consider changes in the relative price between wood and its competitors to be of sufficient importance, and decide that they will last for a sufficient time, substitution would probably be made.

High living standards require the abundant use of wood, and it is difficult to envisage the spread of knowledge throughout the world without wood in the form of paper. In 1955, the world used over 196 million cubic meters of round wood for the manufacture of the products of the pulp and paper industry. This was 23% of the total round wood consumed

for all purposes. Of this total, the United States consumed almost 50%.

During the period 1925 to 1952 the world consumption of roundwood for woodpulp increased 140%. In the United States during the same period, the increase in consumption of pulpwood was 308%. Despite the phenomenal growth made during the period cited, expansion continued and the use of pulpwood in the United States rose an additional 46% between 1952 and 1959. Expansion plans of the industry, projected until 1963, indicate a still further increase in the demand for pulpwood. The American Pulp and Paper Association expects an expansion in capacity of 2 million tons in the United States during the period 1960 to 1963.[1]

Table 5 shows the trend in the use of pulpwood in the United States since 1926. For a more detailed picture see Table 3 in the Appendix.

Table 5. Annual U. S. Pulpwood Consumption - 1926-1959

Period	Total Consumption	Imports	Imports as % of Consumption	Domestic Production
	(thousand cords)			
1926-30	7,103	1492	21.0	5,611
1931-35	6,673	880	13.2	5,793
1936-40	10,572	1318	12.5	9,254
1941-45	16,634	1538	9.3	15,096
1946-50	20,458	1681	8.2	18,777
1951-55	28,820	1911	6.6	26,909
1959	38,690	1278	3.3	37,412

Source: Woodpulp Statistics, 25th Edition.

An examination of Chart No. 3 will show the comparative rates at

[1] U. S. Pulp Producers Association, Inc., 25th Edition, p. 112.

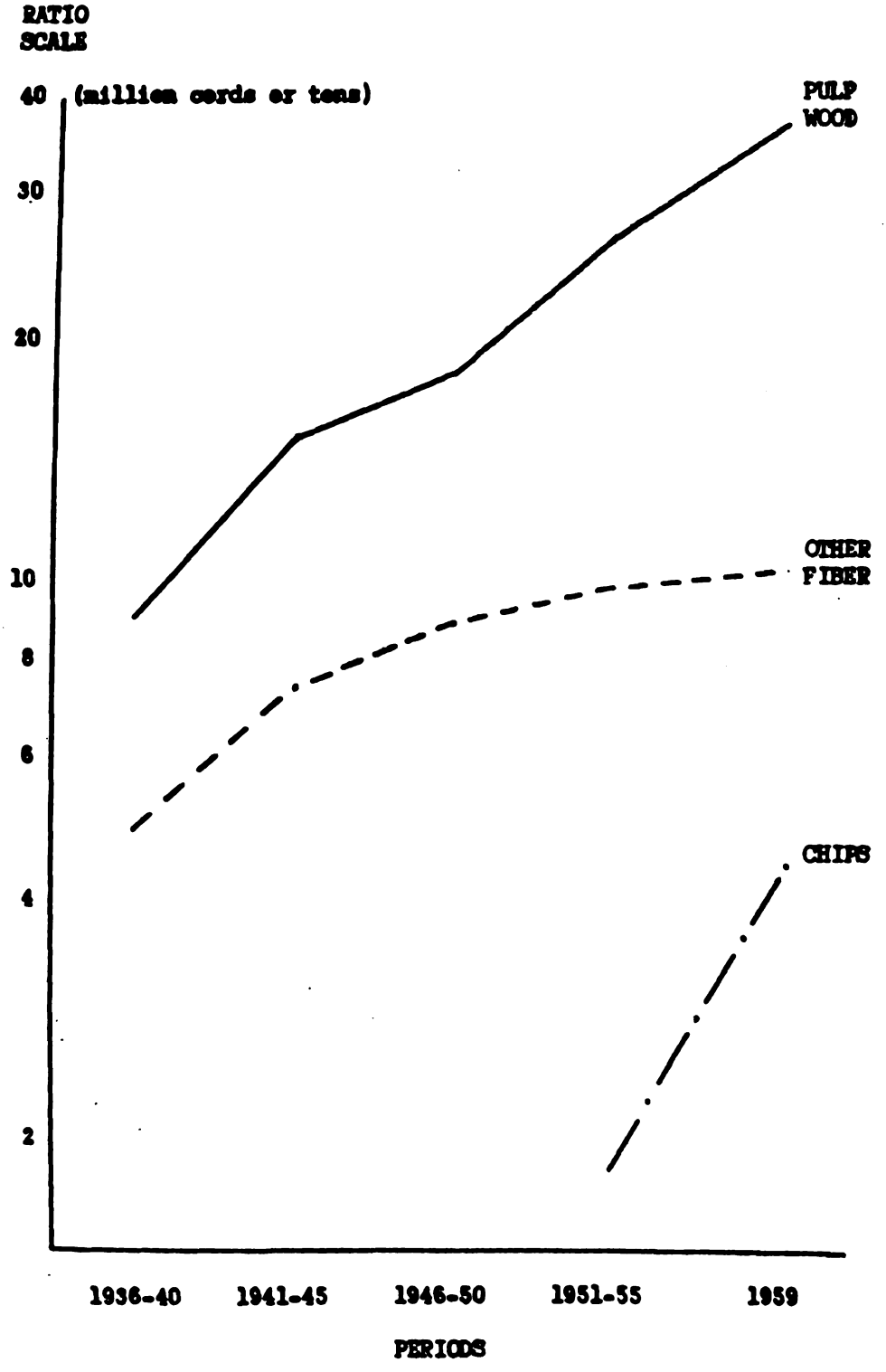

Figure 3. Rates of Change in Domestic Consumption of Pulpwood, Other Fibrous Materials and Chips - 1935 - 1960.

which the demands for pulpwood and "all other fibrous materials"[1] are increasing. Also shown is the rate at which the use of wood residues, in chip form or otherwise, is expanding. It is readily apparent that for the nation as a whole, the use of residues is expanding at a far more rapid rate than either pulpwood or other fibrous materials, while the expansion in the use of other fibrous materials seems to have been arrested, at least temporarily.

In any consideration of the demand for a product such as pulpwood, which is made up of various kinds of wood that are not directly substitutable, it is necessary to examine the requirements by species. An examination of the trends in demand must also be made. Table 6 shows the species of wood demanded by the paper and board industry in recent years and indicates changes which have taken place.

From Table 6, it is obvious that, despite the recent growth in the use of hardwoods in some regions of the country, the softwoods still provide the greatest share of the raw material for woodpulp. On a percentage basis, they account annually for between 81% and 95% of the total production, and there is no indication that, nationally, any great change can be expected. Preliminary estimates for 1959 indicate that 80% of the pulpwood consumed was made up of softwoods.[2] Due to the high percentage of the nation's pulpwood which is supplied by the forests of the South and West, both regions whose timber resources is primarily softwoods, there is little change to be expected in the softwood-hardwood

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[1]Includes waste paper, bagasse, jute, rags, straw, and manila fibre.

[2]Ibid., p. 105.

Table 6. Domestic consumption of pulpwood by species, 1930-1957.

Species	Years				
	1957	1954	1947	1939	1930
	(thousand cords)				
Spruce-Fir	7,961[1]	4,249	3,995	2,992	3,112
Hemlock		2,854	2,904	2,219	1,223
Jack Pine		686	797		
	17,354[2]			4,194[2]	1,231[2]
Southern Pine		14,010	8,145		
Other Softwood		1,251	954	N.A.	N.A.
Total Softwoods	25,315	23,050	16,795	9,405	5,566
% Softwood	81%	83%	87%	95%	93%
Poplar		1,208	882	477	451
	3,062[3]				
Southern Hardwoods		1,558	840		
Northern Hardwoods		979	577		
Other Hardwoods	3,073[4]	983	251		
Total Hardwoods	6,135	4,728	2,550	477	451

1 - includes spruce, fir, and other softwoods
2 - includes all pines
3 - includes poplar and gum
4 - includes all other mixed hardwoods
N.A. - not available

Source: U. S. Pulp Producers Association, Inc., 25th Edition.

ratio within the next five years at least. The softwood-hardwood ratio of the future will in all probability be determined to a greater extent by the supply than by the demand factors.

Due to the broad species classifications used in pulpwood summaries, it is difficult to discern any trend in the demand for species-groups on a national basis, especially within the softwood component. However, during the relatively short time that adequate hardwood pulpwood statistics have been available a definite upward trend is conspicuous in the demand for all the species-groups shown. This is expected to continue as many sulphate mills adapt their processes to the use of hardwoods. With the advent of new board mills using the semi-chemical process, the utilization of a greater proportion of the broadleaf species can be expected. It is evident that the economic pressures of supply and demand must lead to their increased use.

During the period 1926 to the present, the decrease in demand for imported pulpwood is quite evident. Despite the fact that over most of the period the use of imported woods increased, it is evident from a glance at Table 5, that this source has provided a constantly decreasing percentage of the domestic demand for wood. Recent statistics show moreover an absolute drop in the volume of imports. Canadian policy regarding the exportation of pulpwood to the United States has forced some domestic firms to either supplement their lack of desirable softwoods with imports of softwood woodpulp, or to modify their processes for the use of local woods. Both courses of action have been taken and will be continued as long as price does not force their curtailment.

In addition to the direct imports of pulpwood the paper and board industry brings in from foreign sources a considerable volume of woodpulp

of various grades. The annual volume of this material appears to have stabilized at about the 2¼ million-ton figure since the end of World War II.[1] (See Table 4 in the Appendix). If this material had to be furnished from domestic sources, its equivalent in pulpwood would be approximately 3.8 million cords. A great part of the imported woodpulp is used by the converting industry, but it would have to be supplied by domestic pulp mills, if for some reason the supply were to be curtailed.

Demand for Pulpwood in the Lake States

The demand for pulpwood in the Lake States region has continued to increase at a respectable rate of 2.2% over the period 1924 to 1959. However, over the more recent period, 1950 to 1959, the rate has increased to 3.6%. Although still not approaching the national average growth of 5.1% made over the same period, it does show an increase over the rate for the longer period, indicating a developing demand on the part of the region.

Of much greater interest, however, is the changing demand for pulpwood species within the area. Table 7 shows the percentage of total consumption made up by the major species in selected years.

The rapid expansion in the use of hardwoods over the past decade is readily apparent. The percentage of total consumption made up by the broadleaf species increased from 33 to 49 over the recent 10-year period, and present indications are that their use will soon exceed that of the softwoods. It is interesting to note that the rapid extension of the use

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[1] Ibid., p. 68.

Table 7. Consumption of pulpwood in the Lake States--1924-59.

Species	Years					
	1959	1955	1950	1947	1945	1924
	(in per cent)					
Spruce-Fir	25.9	36.6	41.0	47.5	43.5	51.2
Pine	22.1	17.5	20.1	22.2	20.9	6.3
Hemlock-Tamarack	3.2	3.6	5.8	8.5	12.6	41.1
Softwoods	51.2	57.7	66.9	78.2	77.0	98.6
Aspen-Birch	41.2	38.3	30.6	21.4	21.7	1.4
Misc. Hardwoods	7.6	4.0	2.5	0.4	1.3	0
Hardwoods	48.8	42.3	33.1	21.8	23.0	1.4
	100.0	100.0	100.0	100.0	100.0	100.0
Total (thousand cords)	3,393	2,945	2,419	2,663	2,517	1,606

Sources: Wood Pulp Statistics - U. S. Pulp Producers Association.

Technical Notes, Lake States Forest Experiment Station.

Pulpwood in the Lake States - American Paper and Pulp Assn.

of hardwoods has not been confined alone to aspen, the species which has received the greatest notoriety within the region, but that the recent advance in the utilization of other mixed hardwoods has been even more spectacular. It is noteworthy that in Michigan all but two of the larger more modern mills are hardwood users. Recent evidence indicates a greatly increased interest in the use of pine on the part of some mills.

Within the softwood component, the only species which has been able to hold its own over the past decade has been jack pine. The use of spruce and fir has been declining steadily, with the decrease in spruce consumption being the more evident. The reduction in the utilization of hemlock is by far the most spectacular, and there is little reason to look for any change in the present trend in that species. The demand for tamarack which declined notably during the height of the larch sawfly epidemic, appears to be on a slowly rising course now.

It is evident that the future demand for pulpwood in the Lake States will be greatly influenced by the supply and price of the local woods. Present evidence is that overall demand will continue to climb, and at an increasing rate. A critical analysis of species consumption indicates that the hardwoods will continue to make up an increasing proportion of the pulpwood used in the region, with an ultimate utilization of over 60% expected. Present trends point to a continuing decrease in the use of hemlock and spruce, and a stabilization, on a percentage basis, of the demand for pine, fir, and tamarack. Chart 4, which is plotted on a logarithmic scale, shows the rate of increase or decrease in the use of the major species.

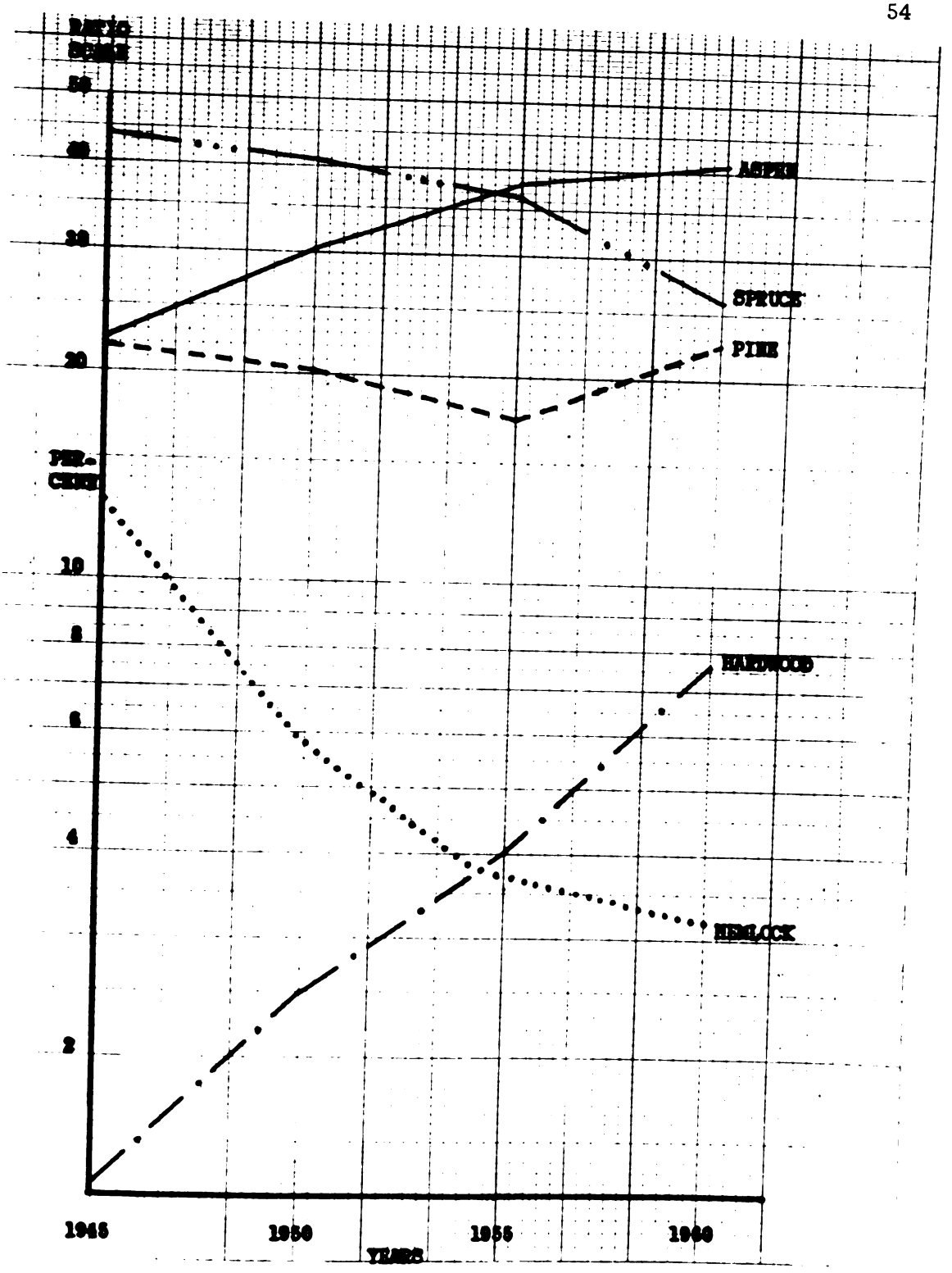

Figure 4. Rates of Change in Consumption of Pulpwood in the Lake States by Species - 1945 - 1960.

The area imports considerable amounts of both pulpwood and woodpulp for its primary and converting plants. The pulpwood volumes are included in the regional consumption table, but the volume of woodpulp is not. It is estimated that from 400 to 600 thousand tons of imported woodpulp are consumed annually by regional plants, mostly in the converting field. In terms of additional pulpwood needs, if this material was to be supplied from local sources, the figure would be between 600 thousand and 900 thousand cords. This would raise the present pulpwood or pulpwood equivalent demand to over the 4-million cord mark.

VI. SUPPLY OF PULPWOOD

The pulp and paper companies of the United States respond to the predictions of future pulpwood requirements in various ways. There are some who simply refuse to believe the forecasts. Still others view them with alarm, but do little about it. However, the majority have taken the predictions seriously and have dedicated themselves to a constructive approach designed to solve the problem before the full impact of the increased needs is upon them. Three courses of action have been followed in an effort to assure that the future pulpwood requirements will be available:

1. increasing the use of hardwoods.
2. increasing the use of residues.
3. increasing the production of wood from all lands dedicated to that purpose.

Other actions can be taken, but these, in general, are considered as only "stopgap" measures to be applied, if at all, only during the interim period while the factors above are working to accomplish their mission. These additional actions are comprised of such procedures as:

1. increasing the use of imported pulpwood.
2. increasing the use of imported woodpulp.
3. temporary shutdowns or halts in the expansion of productive capacity.
4. the substitution of "other fibrous materials" for pulpwood.

All of the measures cited above are important if the industry is to be

sustained and grow, but the main reliance must be placed upon the growing of more timber on the available lands, if it is to rest upon a firm foundation. The element of uncertainty in the import field only intensifies the need for more forestry measures to increase domestic production.

Recognizing that the available forest acreage of the Lake States is in stable ownership, that it is quite productive and accessible, and that a fairly large industrial complex provides markets for its products, there appears to be no reason why the intensification of timber growing should not be favorably considered by all forest landowners in the region. However, as Albert C. Worrell so aptly phrased it in his discussion, there are many factors to be considered in the evaluation of the possibilities of intensified forest management by landowners. Albert C. Worrell listed the primary ones as:

1. the characteristics of the forest land resource itself.
2. the demand for its products as reflected in price.
3. the available supply of capital and labor.
4. the political and social variables influencing the economic considerations.[1]

All have an important bearing upon any decision to intensify the degree of forest management practiced on any tract.

Economics of Pulpwood Supply

The market supply of pulpwood may come from two general sources: (1) existing stocks or inventories, or (2) new production. Both sources

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[1]Albert C. Worrell, "Optimum Intensity of Forest Land Use on a Regional Basis," Forest Science, Vol. II, No. 3 (September, 1956).

are important in the national pulpwood market, with inventories assuming a much greater significance in those regions where continuous production is not possible. In fact, the regularity or continuousness of production is a factor which exerts the greatest influence upon the size of the inventory to be carried. As the carrying of a large inventory is costly, most firms are endeavoring to find means whereby pulpwood operations can be maintained throughout the year, and a large portion of their needs can be supplied from new production currently. It is needless to emphasize at this point that continuity of production is impossible without an adequate pulpwood resource base.

The supply of pulpwood reaches the mills of the country in many forms, principally as logs, rough and peeled bolts, chips, slabs and other waste. It is transported primarily by three methods, each of which has many modifications. Nationwide the greatest percentage of wood travels by rail, with truck transportation being a rapidly growing second method, and movement by water declining. Labor for the logging is provided by farmers, part-time and full-time contractors and subcontractors (in some regions called producers and dealers) and by mill crews.

Throughout the nation, supply appears to be ample and warrants continued expansion of the industry. However, a word of caution must be injected here relative to the scarcity and high cost of the favored species. In most regions, the expanding competition for the highly-regarded species of pulpwood has led to the following consequences:

1. increase in the stumpage value of wood close to the mill causing increased delivered price.
2. increase in the average transportation costs as plants

endeavor to get cheaper wood from more remote areas, with the same results as 1.

3. substitution of other, less-favored, species or waste material for those in short supply, often necessitating "grade shifting," plant renovation, and the seeking of new sales outlets.

Generally the elasticity of supply of pulpwood is variable. In areas close to the mill and which are accessible, normally considered as the intensive margin of production, price increments seem to have little influence upon the increasing of supply, and it is inelastic, particularly for the favored species. However, at long distances from the plant (the extensive margin) where competition is less active and the sellers' opportunities fewer, supply becomes much more elastic and small price increments or even non-price benefits may call forth sizable increases in production.

Much of the variation in the short-run elasticity of supply of pulpwood is correlated directly with season and weather. During periods of bad weather, when transportation from the woods and woods work must often be curtailed, supply becomes very inelastic and inventories must be relied upon to sustain production. Then too, during seasons when other productive processes, such as farming and mining, vie for the available labor, inelasticity of supply is evident. However, for areas where an abundant supply of part-time labor is available in addition to an adequate supply of wood, the supply becomes quite elastic.

In the future, as forest management becomes more intensive and much of the wood supply is obtained within each mill's timbershed, short-run

supply should become quite inelastic and contracts for wood will be made well in advance of delivery at negotiated prices. Price advances or declines should have relatively little effect on the volume brought forth as landowners abide by their management plans. However the supply price at that time will have to be equal to the average cost of production or land will be used for some alternative purpose.

For areas relatively close to import sources of pulpwood, the supply becomes much more elastic and will continue so as long as the product remains a "free good" relative to tariffs or embargoes.

The prior discussion has dealt almost entirely with the short-run supply, which for pulpwood might be considered a one-year situation. In the long run, supply could become quite elastic as new procurement areas are discovered, and additional species utilized. In the long run, the elasticity of pulpwood supply can be influenced to some degree by government actions, such as tax policies, Agricultural Conservation Program payments, and forest protection measures, all of which might be designed to increase supply by decreasing the costs of growing timber. These measures would tend to increase the elasticity of supply in the long run.

Landowner Policies and Programs in the Lake States

The supply of pulpwood needed to sustain regional plants in the future will probably have to come from the present commercial forest acreage of the region. The present and future policies and programs of landowners should be of the utmost concern to the pulp and paper industry.

Since public agencies control 40% of the commercial forest land of the region, and since their holdings are in relatively large consolidated blocks, it is expedient first to consider the policies of the various public forest services operating in the area.

The Federal Services consist of the National Forest Service, Indian Service, Fish and Wildlife Service, and Bureau of Land Management, and each has the administration of some land within all three states. The National Forest Service has the largest acreage, and the most comprehensive program, and it is probable that its lands will contribute the greatest volume of the industry's supply coming from federal lands in the future.

The national forests of the region have stabilized insofar as acreage is concerned, with any recent changes in the amount of land within them being minor and made in the form of purchase or exchange to consolidate present blocks. The administration of the national forests is dedicated to a policy of growing the greatest volume of high-quality sawtimber possible as the primary timber crop, and to the practice of "multiple use" upon all of its lands.[1] Within the past two decades, the volume of timber removed from the national forests of the United States has increased rapidly, as demand for forest products has been good. How long this trend will continue will depend upon the future economic condition of the nation and of the world, for much of the national-forest timber is remote and not too accessible, and cuttings from this ownership are often the first to be curtailed in periods of recession.

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[1]U. S. Department of Agriculture, Forest Service, Report of the Chief of the Forest Service, 1959, July, 1960.

Present national-forest policies are geared to bringing the annual cut up to the maximum level possible under sustained-yield management. This aim is often not realized due to lack of administrative funds or poor markets. However, in future years with the application of still more intensive management, and the alleviation of the accessibility problems, these lands will have the potential to provide forest industries with a greater share of their needs.

The past 5-year period may be taken as indicative of the strides made by the national forests of the region in the sustaining of the pulp and paper industry. Table 8 summarizes the volumes of pulpwood contributed by the national forests of the Lake States.

Table 8. Pulpwood volumes from the National Forests of the Lake States, 1955-1959.

Year	State			Regional Total	% of Lake States Pulpwood Production
	Michigan	Minnesota	Wisconsin		
	(thousand cords)				
1959	226.3	234.0	115.6	575.9	19
1958	193.4	221.4	126.7	541.5	21
1956	150.5	185.1	118.3	453.9	15
1955	134.1	199.4	101.6	435.1	18
Total	704.3	839.9	462.2	2,006.4	
% of State Pulpwood Production	19%	22%	13%	18%	

Sources: Technical Notes, Lake States Forest Experiment Station, Cutting Reports of National Forests - Region 9.

From an examination of Table 8, it becomes evident that the national forests are supplying over 18% of the pulpwood produced within the Lake States, despite the fact that they only encompass 10% of the commercial forest land of the region. It is also of interest to note that in each state, the national forests supply almost twice as large a percentage of that state's pulpwood output as they contain of its commercial-forest area. This attests to the generally more intensive forestry being practiced upon them and the better silvicultural condition of the national forests.

It is evident that the industry will continue to acquire from 20% to 25% of its wood from this source unless a future change in Forest-Service policy were to curtail wood production in favor of some other land uses.

The Indian Service is responsible for the administration of 1.1 million acres of commercial forest land within the Lake States region. Nearly 500 thousand acres of this are located in two Indian reservations, one in Wisconsin and the other in Minnesota. These two areas have been under fairly intensive forest management since 1916, and the additional 600 thousand acres have been under sustained yield operation since 1934. The cut from this ownership appears to be correlated with the acreage of the ownership. In Minnesota, where the Indian Service administers 23% of the federal commercial forest land, these lands provide 23% of the cut taken from all commercial forest land under federal jurisdiction.

The Bureau of Land Management was responsible for the administration of 115 thousand acres of unappropriated public domain within the region in 1946. The forest survey of that year stated that "very little of this now supports or is capable of producing timber of commercial

quality."[1]

The Fish and Wildlife Service which administers approximately 6% of the federal commercial forest land in the region is committed to a policy of "good forestry practices when they do not conflict with the major objective of protection and propagation of game birds.[2]

Most of the remainder of the public lands of the region, amounting to 26% of the total commercial forest area, is administered by state and county agencies, and the policies followed are quite variable. Generally the policies have been patterned after those of the federal Forest Service, and as a consequence "multiple use" and the ultimate production of high-quality saw timber appear to be the principal aims. However, the emphasis placed upon sawtimber production does not appear to be as great as it is in national-forest policy. However, the "multiple use" concept, as applied by this class of ownership, places more stress upon the other forest-land uses than the federal policy does.

Most of the land falling under this ownership category was acquired during the 1930's when it went tax delinquent, and as a consequence, it is, as yet, not up to the standard of the federal lands in timber production. However, the potential is there, and greatly increased production should be forthcoming in the near future.

Within the region, state and county lands which have not been returned to the tax rolls have been organized into state and county forests under the administration of permanent forces enlisted for that

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[1]U. S. Department of Agriculture, Forest Service, Forest Resources of the Lake States (Forest Resources Report No. 1, 1950), p. 18.

[2]Ibid.

purpose. In many cases the lands are widely scattered, adding to the difficulties of administration, and the problem of consolidation looms large in administrative plans.

An examination of the Biennial Reports of the three states over the past decade indicates that for Michigan the area of dedicated state forests has stabilized at just over 3-3/4 million acres. In Wisconsin, the area under county administration seems fairly stable at just over the 2 million-acre mark. However, the state forest program there is a rapidly expanding one, with a 10-year increase from 265,000 acres to over 360,000 acres. In Minnesota, the situation is not quite so sharply defined, as there appears to be no clear-cut separation between state and county administration of public forest lands. By 1960, there were over 3 million acres in state forests being administered under several different statutes, and an additional 1-3/4 million forested acres of state land fell outside this category. The Division of Forestry underwent extensive reorganization in 1956-57, and it is expected that a much more concrete policy for the handling of the state and county-owned forested areas will be forthcoming.

It is interesting to examine the trend in pulpwood procurement from the state and county forest lands of the region. Table 9 gives this information for selected years over the past decade. From Table 9 it is evident that not only is the volume of pulpwood produced from the state and county forests of the region increasing, but it is continuing to provide a constantly greater percentage of the total regional production. This is to be expected, because much of this land is only now coming into production.

Table 9. Pulpwood volumes from state and county forests of the Lake States - 1950-60.

Years	State: Michigan	State: Minnesota	State: Wisconsin	Regional Total	% of Lake States Pulpwood Production
	(thousand cords)				
1958-60	197.2	380.0	N.A.	---	
1956-58	194.0	360.0	130.0	684.0	24
1954-56	159.0	257.0	121.0	537.0	20
1952-54	99.0	243.0	117.0	459.0	21
1950-52	76.0	191.0	105.0	361.0	15
Total	725.2	1,431.0	473.0	2,041.0	
% of State Pulpwood Production	16%	30%	18%	20.6%	

Sources: Biennial Reports of Michigan, Wisconsin, and Minnesota Departments of Conservation. Personal correspondence with State Chiefs of Forest Management. Volumes were rounded off in some cases where information was approximate.

Presently the state and county forests are providing between 20% and 25% of the regional production and make up 26% of the commercial forest land of the area. It is probable that this ownership component will provide over 30% of the regional pulpwood within the near future, if present trends continue. Each state appears to be making strides in their timber-sales programs.

Whether this ownership will continue to increase their pulpwood output will, like the future of national-forest production, depend to a large extent on the prospective land policies of the several states.

Anticipating that larger volumes of pulpwood will be provided from public lands in the future still does not alter the fact that for the region, between 40% and 50% of the wood for the pulp and paper industry comes from private lands owned by farmers, miscellaneous landlords or industry. This group owns 60% of the commercial forest land of the Lake States and has until recently provided well over 40% of the regional production. Table 10 gives the estimated percentage of total wood used, by sources of procurement.

Table 10. Sources of pulpwood for Lake States' mills--1952 and 1959

Year	Land Ownership			Imports
	Public	Private	Industry	
	(in per cent)			
1952	33	29	8	30
1959	38½	40	9	12½

It is anticipated that these private ownerships will continue to provide 50% of the wood used by the regional industry, providing their small-size holdings do not cause the price of wood to become too expensive due to the inability of practicing efficient mechanized harvesting methods upon them. Leaders in the industry anticipate that these lands will provide work for the part-time laborer-owner in the future, but that the large assured volume of wood, so necessary to sustain the industry, will come from the larger public and private holdings upon which mechanized operations are possible.

A great deal of effort has been expended to bring about better forest-management practices upon the small forested areas of the country.

To date, it has paid off only on the larger acreages, and relatively little has been accomplished on the small farm holdings. Many investigators in all sections of the country have concluded that the intensity of forest management on farm and other private holdings is directly related to the size of the forest property, and that there is little evidence to indicate any relationship between intensity of operation and any owner characteristics.[1] It is evident that the small size of a great proportion of these ownerships is an obstacle to the practice of intensive forestry because of the limited infrequent incomes they afford and the inefficiency of harvesting and marketing which can be practiced upon them.

The future policies of all forest landowners in the region are of tremendous importance to the pulp and paper industry for it appears that its supply of wood will be coming from these properties to an even greater extent in the next decade than it is today.

The policies of public forest administrations are constantly open to the influence of pressure groups. Albert W. Wilson cites a warning to the industry by the U. S. Chief Forester:

> Multiple use must win the fight or industry will not get the timber it needs . . . I caution you as a consumer of wood that multiple use is being vigorously attacked. There is an upsurge in demands for recreation lands. Earnest dedicated people are in this battle. You are entering a decade of decision as to our long range timber supplies.[2]

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[1] U. S. Forest Service, Timber Resource Review, pp. 289-314.

[2] Albert W. Wilson, "Warning to Pulp and Paper by U. S. Chief Forester," Pulp and Paper (April, 1960), p. 68.

It is becoming increasingly clear that a great deal of pressure is being brought to bear by many groups upon the public forest administrators in an effort to secure consideration for their preferential uses. Much of the pressure has little logical guidance, but it is strong and can contribute to the modification of timber-growing practices for maximum output, or even to the complete elimination of large areas of commercial forests from the practice of timber growing and sale. Dean Walter F. McCulloch speaking particularly of the recreation pressures being exerted on the West Coast stated that:

> . . . we can afford to take only so much land out of production if we are to maintain the economic activity which makes possible recreation activity.[1]

To indicate that these problems are not confined along to the West Coast, it is of interest to note that as early as 1950, Michigan had over 300,000, Minnesota 1,200,000, and Wisconsin 42,000 acres in areas reserved from cutting. This was a total of over 1½ million acres which had been abstracted from the production of timber for industrial purposes.

Wildlife management can be practiced on forest lands along with good timber management providing it is logical and sound. Good wildlife management, as is true of good timber management, demands that the resource be used and that herds be kept within the maximum dictated by available forage and the requirements of good timber management. If this is not done both resources will suffer. That this problem is currently a major one to many forest managers in the region is shown by statements from the Ottawa National Forest and the

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[1] Walter F. McCulloch, "Capacity of Pacific Northwest Forests to Meet Future Demands," Proceedings of Citizens' Conference on Pacific Northwest Forest Resources (Reed College, June, 1959), p. 23.

Wisconsin Conservation Department which proclaim that if the forests are to produce for the future and assure the dependent industries of an adequate and continuous supply of wood, immediate steps must be taken to eliminate the overpopulation of deer.[1]

With the multitude of pressures being brought to bear today to modify the use of forest lands, it is important that the public be informed of the consequences of many of the modifications upon the future industrial expansion of the region and the jobs which this makes possible. Bruce G. Buell, Chairman of Wisconsin Forest Industries, expressed the need for public enlightenment when he said:

> The public must be made aware of the deep economic impact and many permanent benefits of forest management. Wisconsin citizens must be convinced that the forests are needed for growing and harvesting trees to meet the wood demands for our society. But, compatible with this primary purpose, is the production of other values of vital concern to everyone.[2]

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[1] Ottawa National Forest Progress Report, 1959.

[2] Bruce G. Buell, "Expressions," American Tree Farmer and Forestry Digest, July, 1960, p. 19.

VII. PRICE OF PULPWOOD

Price development in the pulpwood market is of tremendous interest to everyone connected with it, from landowners to industrial managers. It can be assumed to exercise a strong influence on the demand and supply functions when considered in conjunction with the price and quality of substitutes. In fact, the ultimate balance between the supply and demand for pulpwood like that for paper and board will probably be largely governed by the price, for price can influence the substitution of wood by other materials and vice versa. It is of extreme importance to both consumers and producers that the price of pulpwood should not become so prohibitive that it seriously restricts consumption. In total costs of production by the various pulping processes, it appears that the cost of wood delivered and barked covers from 25% to 55% of the total production cost of slush pulp with the coniferous species responsible for the high figure and the broadleaf species for the low.[1]

The price of pulpwood is primarily influenced by the costs of stumpage, logging, and transportation to the mill. In most regions, the cost of stumpage has had the slightest effect on the value of wood delivered at the mill, often amounting to 10% or less of the delivered price. However, in some areas this situation is changing rapidly and stumpage is taking nearly a third of the total. In areas close to the

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[1]FAO, Raw Materials for More Paper (Forestry and Forest Products Study, No. 6; Rome: Dec., 1952).

mill where transportation can be carried on by truck on public highways and is consequently relatively inexpensive, the stumpage value on preferred species may take as much as 50% of the delivered price of wood.

Transportation costs of pulpwood assume considerable economic importance to the pulp and paper industry, often averaging from 20% to 35% of the delivered price of the wood. The present emphasis on increase in the size of the manufacturing plant, to take advantage of economies of scale in production, leads to the expansion of the area of supply of raw materials. This in many cases has necessitated an enormous extension of the procurement zone, with its accompanying increase in average transportation costs.

Logging, the operation from stump to rail or mill, takes 30% to 60% of the delivered cost of the wood. The costs of this operation are greatly influenced by the volume cut per acre, the size of the sale, duration of the operation, weather, and topography as well as by such items as the amount of road to be built, and length of the haul to the mill or major transportation point.

In addition to the three primary factors influencing the price of pulpwood, the element of bargaining power often plays an important role in determining the eventual market value of the product. As the timbersheds of different firms overlap and procurement-men from several mills are in the market for the same timber, the price of market wood can be enormously affected by this factor. Conversely, if only one firm is buying in an area, the equivalent of monosony exists.

Although pulpwood has provided the greatest proportion of the fibre used in the manufacture of paper and board in recent years, other materials

are available and at times provide a substantial percentage of the input of the industry. Pulpwood in recent years has provided between 65% and 70% of the fibrous material used, with waste paper averaging 28% and "all others" about 3½%. Despite the fact that the utilization of substitutes is presently relatively small, their presence and availability can be a contributing factor in the establishment of pulpwood prices, particularly in the long run.

Past Prices of Pulpwood

United States

It seemed evident from the consideration of the pulpwood supply problems in Chapter 6 that the general trend in the delivered price of pulpwood should be upward. Two factors were considered chiefly responsible for this movement: (1) increases in the stumpage values of wood close to the plant due to developing scarcity, and (2) increases in the average transportation costs of wood due to the necessity of enlarging the procurement area when local shortages developed. A third factor, increased logging costs brought about by higher wages, lower cut-volumes per acre, and more remote and inaccessible "chances", accentuated the movement.

The factors responsible for increases in the average delivered price of pulpwood have been counterbalanced however by the action of two operations which resulted in the decreasing of price. These are: (1) the substitution of less-favored species and residues for the high-priced woods and (2) the mechanization of much of the logging operation. Had it not been for the latter two developments, it is difficult to visualize

what the present situation might be relative to the price of pulpwood. Table 11 gives the average costs per cord, f.o.b. mill, for all pulpwood consumed in the United States for selected years. Column 3 gives the average cost deflated to constant (1947-49) dollars.

Table 11. Average cost per cord of pulpwood f.o.b. mill--1919-1954

Year	Cost (per cord)	*Deflated Cost (per cord)
1954	$19.57	$17.75
1947	17.83	18.55
1939	7.82	15.60
1935	7.64	14.70
1931	10.94	23.10
1929	13.09	21.20
1919	15.95	---

*Deflated by use of Bureau of Labor Statistics Index of all Wholesale Commodities (1947-1949 = 100).
Source: Pulpwood Statistical Review, American Pulpwood Association.

There appears to be no particular trend in the cost of pulpwood on a nationwide basis when prices are deflated to allow for changes in the value of the dollar over time. Evidently the two compensating factors enumerated above have done much to prevent the potentially rapid increase in the price of pulpwood engendered by the action of the three factors responsible for movement in that direction. Whether the operation of the compensating factors listed, plus any innovations, can continue to keep pulpwood prices constant is of the utmost importance to the industry and to the consumers. It will take the concerted efforts of everyone connected with the industry, from forester to mill personnel, to prevent price increases in pulpwood of a magnitude in excess of those of

all other commodities.

Lake States

The factors responsible for changes in the price of pulpwood have been operating throughout the United States, but each exerts a varying amount of influence when considered on a regional basis. It is well, at this point, to examine the changes which have taken place in the Lake States relative to pulpwood prices, and to compare these changes with those of other competing regions. An effort will also be made to analyze the factors primarily responsible for the regional changes, and to recommend procedures which might be utilized to keep pulpwood prices in line with the average for all other commodities.

Table 12 gives the prices, f.o.b. cars, of some of the important regional pulpwoods and compares them with southern pine and hardwood for selected years. In addition, the rate of increase for two periods is given. Chart 2 also shows the rate of increase in the price of several woods.

From a perusal of Table 12, it is evident that the rate of increase in the price of Lake States pulpwoods over the period 1940 to 1959 has been slower than that of southern pine, and that even over the recent shorter period, 1950 to 1959, the regional softwoods have remained competitive and aspen has increased at the phenomonally low rate of only 1.9%. On the basis of deflated prices per cord, spruce has remained fairly constant at $22.00 and southern pine at $13.00 since 1945. However, aspen has fallen to below $10.00, while jack pine has increased to $18.00.[1]

[1]Actual prices deflated by the Index of All Wholesale Commodities.

Table 12. Average price of pulpwood, f.o.b. cars--1940-1959

Year	Species					
	Aspen	Jack Pine	Spruce	Southern Pine	Southern Hardwood	Northern Hardwood
	(rough cords)					
1959	11.50	18.00	26.25	15.60	12.50	12.50
1955	11.50	17.50	24.75	14.40		
1950	9.50	13.25	19.50	11.90		
1945	9.60	12.75	15.00	8.40	8.10	10.00
1940	4.25	N.A.	9.00	4.20		
Compound Rate of Increase						
1940-59	5.1%		5.5%	6.8%		
1950-59	1.9%	3.1%	3.0%	2.7%		

Source: Demand and Price Situations, p. 29.

For comparison, it is interesting to note the f.o.b. mill prices of certain of the pulpwoods in Oregon in a recent period.[1]

	1959	1956
White fir-hemlock and spruce	$14-20/cord	$17.00/cord
Cottonwood	$12-17/cord	$14-23/cord
Alder	$14/cord	$15-18/cord

With a growing percentage of the wood volume of competing regions being marketed in the form of chips, it is interesting to note the present prices. In 1959, in open-market transactions in the South, pine chips averaged $6.21 per ton, and hardwood $4.97.[2] At Iron Mountain, Michigan

[1]Personal correspondence with Charles F. Sutherland, Jr., Forest Economist, State of Oregon, Extension Service.

[2]U. S. Department of Agriculture, Forest Service, 1960 at the Southern Forest Experiment Station (1961), p. 68.

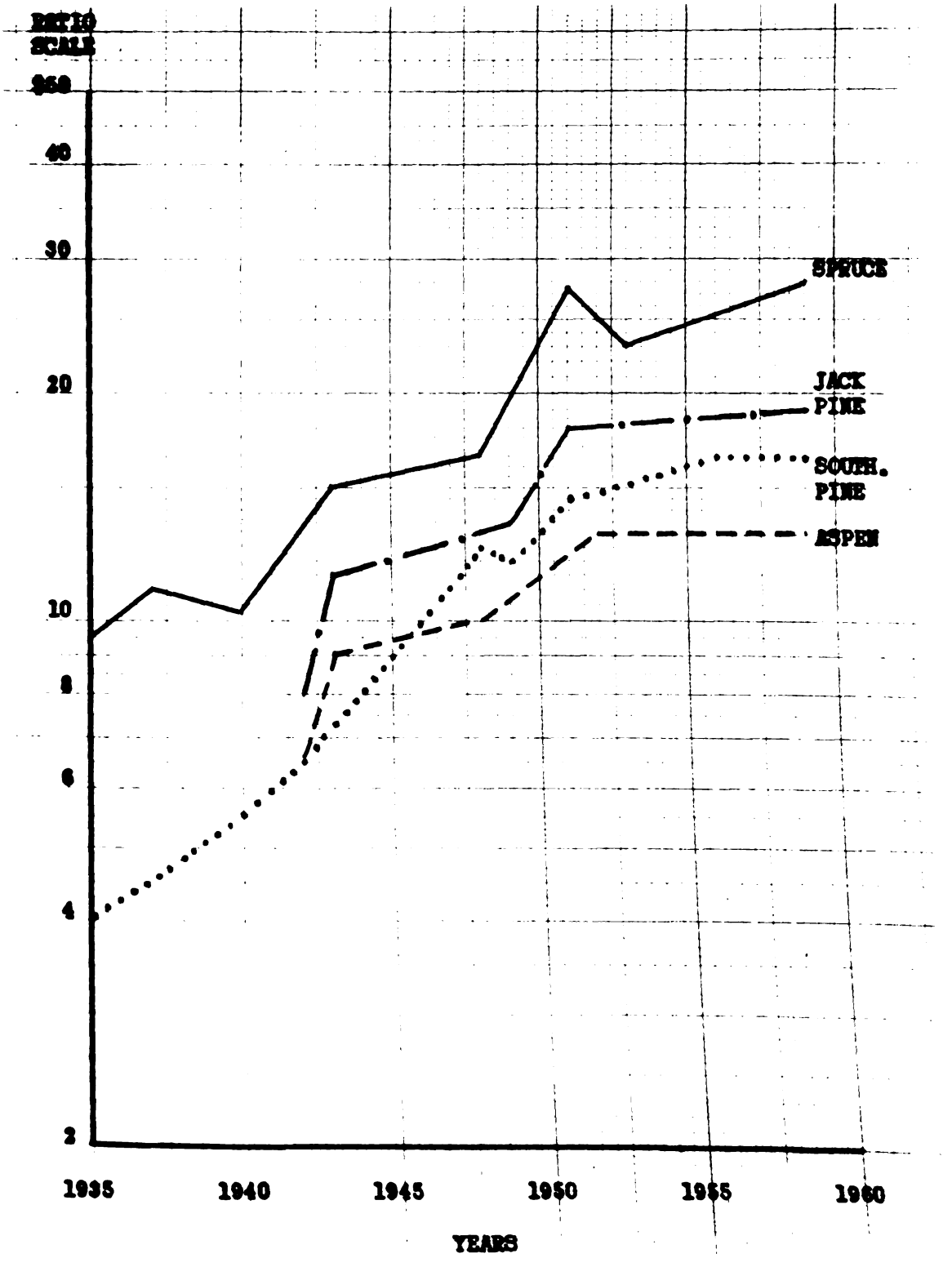

Figure 5. Rates of Change in f.o.b. Mill Prices of Selected Pulpwoods - 1935 - 1959.

chips were bringing $4.03 per ton f.o.b. cars in 1953.[1]

In order to evaluate the effect of transportation costs upon pulpwood, it is necessary to examine the price of various woods delivered at the mill. Table 13 gives an estimate of these values for 1947.

Table 13. Prices of pulpwood f.o.b. mill--1947.

Species							
Spruce-Fir	Aspen	J.Pine	Hemlock	N. Hdwd.	S. Hdwd.	S.Pine	D. Fir
(rough cord)							
$24.58	15.86	19.39	18.28	19.68	14.49	14.42	15.21

Source: Economic Aspects of Papermaking Fibrous Raw Materials. Reprint of F.P.R.S., Wood Technical Series, No. 7 (1950).

It can be seen by a comparison with Table 12 that transportation added about $6.00 per cord to the price of aspen, jack pine, and southern pine at that time, while about $9.00 was added to that of spruce, indicating the effect of the longer hauls of the scarcer preferred species.

It is also of interest to investigate the trends in the stumpage values of the various species in order to evaluate the return to the landowner. However, a great variability in stumpage quotations makes it very difficult to discern trends in stumpage prices. However, it appears that for the Lake States, stumpages have remained quite stable over the past ten years, despite the slowly rising prices f.o.b. cars. This is in decided contrast to the movement of southern pine stumpage,

[1] W. H. Koepp, "Chips from Logging Operations," Pulpwood Annual, 1933 (1953), p. 27.

which has almost doubled over the same period. Despite the use of averages with a wide variance as a basis, the indications are still strong that for the majority of the species used by Lake States' mills, stumpage takes from 10% to 15% of the delivered price of the wood, with spruce absorbing 15% to 20%. This is in contrast to the southern pine price from which stumpage extracts 25% to 35% of the mill price.

Total logging costs to rail head extract from 45% to almost 70% of the price of delivered wood in the Lake States. An examination of cost figures from operations in all three states indicates a wide variability in expenses, as would be expected for operations carried on under such diverse conditions. On examining figures gathered by the American Pulpwood Association and Michigan State University, from operations in all three states, it becomes evident that, on the average, logging costs amount to over 50% of the f.o.b. mill price.

Transportation costs to the mill for regional wood whether shipped via rail or truck appear to extract from $6 to $9 on the average from the f.o.b. mill price, although costs as low as $3 and as high as $14 have been recorded for some Lake States mills. Assuming the averages above, it is apparent that on a percentage basis, the cost of transportation to the mill is responsible for 25% to 35% of the f.o.b. mill price.

Summarizing for the Lake States, it appears that on the average the following ratios are applicable to regionally-produced wood. Column 4 provides a comparison of the Lake States cost distribution with that of average figures for the South. From this comparison it appears that greater competition for the available stumpage in the South is causing the producer to shave his margin in favor of the landowner.

Table 14. Distribution of f.o.b. mill price of pulpwood--Lake States and South

Operation	Percentage of f.o.b. mill price		
	Lake States Average	Lake States Range	Southern Pine Average
Stumpage	20	10 to 35	30
Logging	50	45 to 65	40
Transportation	30	25 to 35	30

Measures to Keep Local Pulpwood Prices Competitive With Those of Other Commodities

If the price of pulpwood is to be kept competitive with that of other commodities, there will have to be technical developments in all phases of the operation from the growing of the product to its conversion into woodpulp. With little evidence of any lowering of wages in the future, these developments will, to a large degree, take the form of expansion in the ratio of capital to labor, in order that the productivity of the workers may be increased.

It is of interest to examine each of the factors responsible for changes in the f.o.b. mill prices of pulpwood and attempt to furnish measures designed to keep the prices of the product fairly stable.

Stumpage

Stumpage in the Lake States doesn't take as large a portion of the delivered price of pulpwood as it does in some other regions at present.

This is a fortuitous situation brought about to a large extent by the fairly recent shift to the use of aspen and hardwoods, both species which are in long supply in the area. As the industry expands however, these species too can end up in short supply, leading to ever increasing pulpwood prices. This time there will be no other woods which can be substituted for the high-priced ones, for within a very short time all species will be finding their way into the plants.

What can be done to keep the price of stumpage from exacting too large a share of the total wood costs? This is a problem for the foresters, whose job it is to raise the wood crop in large amounts as cheaply and efficiently as possible. The initiation of intensive forestry on the forest lands of the Lake States will not in itself be sufficient to accomplish the aims unless it is accompanied by the introduction of measures designed to get the job done cheaply and efficiently, for in the long run the price of pulpwood stumpage will be dictated to a large extent by the costs of production of the crop.

Intensive forestry will have to be initiated upon all the commercial forest lands of the region, if pulpwood prices are to remain stable. The first job then is to examine the forest land ownership of the Lake States, for the initiation of intensive practices is a land-owner's province. Forty per cent of the commercial forest land is in public ownership, 29 per cent in farms, 6 per cent in industrial hands, and 25 per cent falls in the "other private" category.

From an investigation of the figures above, it is obvious that, unless forest ownership changes in the future, a large share of the industry's pulpwood must come from public lands. It should therefore be

of the utmost concern to pulp and paper owners, employees, and users that intensive forest-management practices be initiated on all public forest lands, in order that there shall be a sufficient volume of wood for the future. In addition, the same people should be vitally interested in any policy aiding in the consolidation of the public lands, and in the increasing of their accessibility. Consolidation will allow greater mechanization in the practices of intensive forest management and lead to more efficient administration. Increased accessibility will lower the costs of logging and administration and make possible the salvaging of values which might otherwise be lost to insects and diseases. It would also allow a steadier flow of wood to the mill, and thereby create conditions for a more efficient use of labor, and make the carrying of a large expensive inventory unnecessary.

However, the advocacy of intensive forest-management practices for public lands alone is not enough. If prices are to be kept stable, the remaining 60% of the forest land must also become more productive. Farm and "other private" woodlands at present provide a large share of the market wood, and should continue to do so in the future. The generally small size of the woodlots does not lead to efficiency of operation, but the fact that they are usually readily accessible should make it possible to operate them intensively, and their output could supplement that of the larger more assured production from the public lands. It will therefore be necessary to take steps to aid in the increase of yields from all forest land regardless of ownership.

Logging

Logging extracts the greatest percentage from the mill-price of wood. In the Lake States this portion averages over 50% of the total. If the price of wood is to remain stable, vast improvements must be made in the operation from stump to major transportation artery.

More intensive forestry practices can improve the logging situation immeasurably, for the greater yields per acre will be conducive to the application of mechanization which in turn should result in lower costs and in increased returns to all segments of the operation. In a comparison of costs by different cutting methods and volumes removed, the Lake States Forest Experiment Station found that in 35-year old big-tooth aspen stands the following times were recorded:[1]

Low thinning	(13 cords per acre)	4.0 man hours per cord
Crown thinning	(12 cords per acre)	3.6 man hours per cord
Clear cut	(22 cords per acre)	3.0 man hours per cord

This is indicative of what can be accomplished in the lowering of logging costs when greater volumes per acre became available. It is probable that many changes in harvesting techniques will be forthcoming as the volume-per-acre of timber stands increases with intensive forestry practices. In fact some leaders of industry envisage the future pulpwood forest as resembling a cornfield, with trees replacing the corn stalks,

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[1]U. S. Department of Agriculture, Forest Service, Comparison of Man Hours Required for Thinning and Clear Cutting Pole-Size Aspen (Lake States Forest Experiment Station Technical Note, No. 407, October, 1953).

[2]Newsprint Information Committee, Newsprint Facts, Vol. 111, No. 2 (March, 1961), p. 2.

in which large expensive machines carry on the entire harvesting job in an effort to keep productivity ahead of rising costs.[1]

Intensive practices on public lands should eventually lead to larger timber sales of a longer duration. This in turn should allow the bigger operator to keep and train a permanent labor force which can, through mechanization, greatly increase its productivity and thereby lower costs and provide the industry with a steady assured source of wood.

Leaders of industry look for a steadily decreasing number of pulpwood producers in the future.[2] However, they anticipate that the size of the average producer's cut will be much larger. This leads to the observation that in the Lake States, the steady producer of 500 cords or more must depend to a greater degree upon public agencies for his wood in the future.[3] Therefore, much of the improvement in logging techniques and costs will be closely tied in with the policies followed on public lands.

Transportation

The fact that a large volume of pulpwood moves between the three Lake States, and that an additional volume moves in from areas outside the region, emphasizes the significance of freight rates and transportation arteries to the industry in its procurement of pulpwood.

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[1]Newsprint Information Committee, Newsprint Facts, Vol. III, No. 2, (March, 1961), p. 2.

[2]"Leaders of Industry Look at the Future," Pulpwood Production and Sawmill Logging, Vol. VII, No. 7 (July, 1960), p. 22.

[3]Tom R. Powell, "Lake States to Benefit by Steady Wood Production, Better Use of Public Timber," Pulpwood Annual - 1958 (July, 1958), p. 97.

As better highway systems develop and more efficient truck and trailer combinations are marketed, a greater percentage of wood will reach the mill by this type of conveyance. Not only is more wood being hauled by this mode of transportation, but it is being carried over increasingly longer distances. Therefore, it is of the utmost concern to the industry that a system of all-weather roads be developed which will favor the development of this method of transportation.

A large volume of pulpwood still moves by rail within the region, with many of the Wisconsin mills getting most of their volume by this method.[1] However, the freight-rate structure for the entire region is obsolete and needs revision by the I.C.C. if the railroads are to remain competitive with truck haul.[2] Railroad haul has its advantages, particularly in the fact that large volumes can be moved in a short time regardless of weather, but the present rate structure within the region has caused many procurement men to look with disfavor on this means of transportation. However, for some mills non-price factors outweigh the price differential and large volumes still move via this more expensive method.[3]

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[1]Lee M. James, Marketing Pulpwood in Michigan (Michigan State University Special Bulletin 411, Feb., 1957), p. 27.

[2]U. S. Congress, Senate, Select Committee on Small Business, Hearings on Independent Logging and Sawmill Industry - 1958, 85th Cong., 2nd Sess., 1959, p. 93.

[3]Lee M. James and Gordon D. Lewis,"Transportation Costs to Pulpwood Shippers in Lower Michigan," Quarterly Bulletin, Vol. XLII, No. 3 (Feb., 1960), pp. 444-469.

A few mills still get an appreciable volume of wood by water. This mode of transportation is generally considered very cheap, but since World War II, costs of water movement have increased more than that of rail and highway. In addition, the freeze-up period necessitates the carrying of a large inventory until the spring thaw.

Some combination of all three methods of transportation in conjunction with the establishment of wood yards may be necessary in the future if the costs of transportation are to be kept within the 30% of the delivered price of wood which they now extract. However, in the long run more can be accomplished by the practice of intensive forestry on lands close to the mill, for each additional cord supplied from adjacent lands is one less that needs to be transported from the extensive margin and average transportation costs are thereby lowered.

Substitutes

Although there remain few additional species in the region which can be exploited as aspen has been in recent years, some use can be made of substitutes in an effort to keep pulpwood prices within bounds. The need to secure cheap cellulose fibre remains an important consideration of the industry, and all sources of it have been investigated. However, the economic superiority of pulpwood is unquestioned today, but it can be priced out of the market unless everyone interested in its use works to keep its price competitive.

The use of sawmill and woods residues is becoming an important source of fibre for the industry. However, industry leaders appear to believe that the continued increase in the use of this material will be

at a decreasing rate in the future, for its volume generally depends on the volume of sawtimber available and the condition of the lumber market. Most mills which have used chips declare that they will endeavor, in the future, to utilize all the materials which the sawmills can produce, but that the percentage of their total intake which is supplied from this source remains relatively small. However, in some cases it supplants some of the higher-priced pulpwood thereby indirectly affecting price. In the Lake States region at present over 70% of the sawtimber cut is in hardwood species, and so the chips would be in the same proportion.[1] Little effect therefore would be felt upon the price of the preferred species. However, in the future these hardwood residues may be instrumental in preventing an exorbitant rise in hardwood-pulpwood prices. It is estimated that the equivalent of over one half million cords of coarse residue are being produced now within the Lake States. Over 70% of this is from hardwoods and most of it is being consumed for fuel.[2]

Over the United States as a whole, there is a possibility of great expansion in the use of waste paper as a pulpwood price governor. A supply of over 15 million tons is now available annually with only half of that amount being collected. The Lake States region, with its large urban population centers, is ideally situated for the efficient assemblage of waste paper. However, its use is limited to some extent by such items as high cost of collecting and deinking and the difficulties experienced

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[1]Koepp, Pulpwood Annual - 1953, p. 27.

[2]American Pulpwood Association, Minutes of the Lake States Technical Committee (May, 1959).

in storage. Waste paper, even when baled, is low in density and presents many transportation problems.

The use of the various agricultural fibres has as yet found little favor in the United States, however, they are readily available and research has shown that they can greatly benefit the industry by increasing pulp supplies. FAO states that the reasons they have not been used more throughout the world are:

1. dirtiness and bulkiness.
2. difficulties in collection, transportation, and storage.
3. feeling that yields are low, strengths not high, and that clean pulps are costly to produce.[1]

However, should the price of pulpwood increase too greatly, methods would be devised to circumvent these difficulties, and this source of cellulose could be exploited as a governor on the price of wood.

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[1] FAO, Tropical Woods and Agricultural Residues as Sources of Pulp (Rome: Dec., 1952).

VIII. CAPABILITIES OF THE LAKE STATES TO SUPPORT THE PRESENT PULP AND PAPER INDUSTRY BY THE USE OF LOCAL WOOD

Much has been written about the history of the destruction of the Lake States' timber resource by the lumber industry at the "turn of the century", but relatively little notice has been taken of how the same forests came back to support a bulk-wood industry during the 20th century.

The current annual pulpmill capacity of over 3¼ million tons of wood-pulp, representing an investment in excess of $150 million, and the partially dependent paper-mill trade whose investment brings the total for the industry to $½ billion, have been supported, to a large extent, by local forests. In recent years 84% of the wood used by the region's mills has been produced from the 53¼ million acres of commercial forest land of the three states without depleting the overall resources. The U. S. Forest Service, in fact, estimates an annual surplus (allowable cut minus actual cut) of 879 thousand cords in the northern Lake States alone, and surprisingly it is spread over all the species.[1]

Forest Areas

Any analysis of the capabilities of a region to support its wood-using industries must start with an investigation of its basic resource, land. It is not enough to study the present amount of forest land, but

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[1] U. S. Forest Service, Feasibility of Using Lake States Hardwoods for Newsprint and Other Pulp and Paper Products, p. 44.

it is equally important to examine such things as the trend in amount, the ownership pattern, the forest condition, and the competing uses for the available acreage.

Originally forests covered 103.7 million acres, nearly 85% of the land area of the region. Today roughly half the land remains in timber. Lake States forests constitute 11% of the commercial forest land of the United States.

The residual 53,272,000 acres of commercial forest land in the Lake States is well distributed among the three states as is evident from Table 15.

Table 15. Land Area of the Lake States--1953

Land Use	State			Regional Total	% of Total Land Area
	Michigan	Minnesota	Wisconsin		
	(thousand acres)				
Commercial Forest	18,849	18,098	16,325	53,272	43
Non-commercial Forest	473	1,246	210	1,929	2
Total Forest	19,322	19,344	16,355	55,201	45
Cropland in Farms	9,061	20,901	10,718	40,680	33
Pasture and Range	3,084	4,178	4,619	11,881	10
Other	5,027	6,783	3,139	14,949	12
Total	36,494	51,206	35,011	122,711	100
% in Commercial Forest	52	35	47	43	

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper No. 37), p. 1.

For all practical purposes, the area of forest land and commercial forest land in the Lake States appears to have stabilized. This is to be expected in an area which is industrially mature. The forest surveys of 1938 and 1946 when compared with Table 15 indicate that relatively little change has taken place in the forest-acreage picture during the past decade, and a glance at the 1931 statistics reveals the same pattern.

Table 16. Land area of the Lake States--1945

Land Use	State			Regional Total
	Michigan	Minnesota	Wisconsin	
	(thousand acres)			
Commercial Forest	17,380	16,700	16,265	50,345
Non-Commercial Forest	1,620	3,000	735	5,355
Total Forest	19,000	19,700	17,000	55,700
Total Area	36,494	51,206	35,011	122,711
% in Commercial Forest	48	33	46	41

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper No. 1), p. 2.

Table 17. Land area of the Lake States--1931

Land Use	Lake States	Per cent of Total Land Area
	(thousand acres)	
Commercial Forest	55,895	45½
Non-Commercial Forest	4,450	3½
Total Forest	60,345	49
Non-Forest	62,366	51
Total Land	122,711	100

Source: U.S.D.A., Forest Service, A National Plan for American Forestry, 1933, p. 122.

From a comparison of the three tables, it is evident that although the total forest area has remained almost constant during the period 1931-1953, a small decrease has occurred in commercial forest acreage. This has been due in a large measure to the extraction of area from the commercial forest category and its placement in the non-commercial classification. Most of the acreage so treated was productive forest land which has been reserved for other land uses. To date, this has not been an appreciable segment of the area available for commercial forest purposes, but the trend is evident and more reservation can be expected in the future. However, large shifts in land use from one major use to another are unlikely in the future. The Great Lakes region has matured relative to land use, although there may be some localized changes.[1]

The present ownership pattern of the commercial forest land is interesting because it reveals several facts which can be of great importance to the future of the pulp and paper industry in the region. Table 18 gives the acreage of commercial forest land by ownership groups, and is indicative of the sources from which the wood products of the region must come.

It quickly becomes apparent that for the region as a whole a substantial share of the forest products must come from public lands for Wisconsin has 30% of its commercial forest area in public ownership; Michigan, 34%; and Minnesota, 56%. In Michigan the public lands fall primarily into State (60%) and Federal (40%) ownerships; in Minnesota they are evenly distributed among the three public groups, while in

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[1]Perloff, et al., p. 476.

Wisconsin the federal and county agencies control most of the administration.

Table 18. Ownership of commercial forest land in the Lake States--1953

Ownership Class	State			Regional Total	% of Total
	Michigan	Minnesota	Wisconsin		
	(thousand acres)				
Federal	2,482	3,055	2,003	7,540	14
State	3,819	3,484	444	7,747	14
County	86	3,619	2,447	6,152	12
All Public	6,387	10,158	4,894	21,439	40
Farm	3,877	4,881	6,426	15,184	29
Industry	1,447	578	1,014	3,039	6
Other	7,138	2,481	3,991	13,610	25
Total	18,849	18,098	16,325	53,272	100
% Public	34	56	30		

Source: U.S.D.A., Forest Service (Lake States Forest Exp. Sta. Paper No. 37), p. 3.

Over the region as a whole the farm ownership component is sizeable, accounting for 29% of the commercial forest land. Wisconsin, with 39% of its commercial forest acreage in farm ownership, leads the list. A closer examination of this ownership indicates, however, that it is principally located in the southern part of the region, in an essentially hardwood area, and in most cases in a region remote from existing pulpmills. For this class of ownership the average is 33 acres of woodlands per farm.

"Other private" ownership provides a substantial acreage in the region, accounting for 25% of the commercial forest area. It is a particularly important component in Michigan and Wisconsin where the average

size property contains 120 to 150 acres. Much of this land is owned by estates, non-forest industries and land-holding companies, and 66% of the area is rated in the "high" productivity class.[1] It appears that this ownership, which is well distributed throughout the area, could become an important source of forest products for the region.

Industrial forest ownership in the region is small, amounting to only 6% of the commercial forest area. It is evenly distributed between the lumber and pulp and paper industries, and it appears as though its influence upon the supply of raw materials for the region's wood-using industries will be slight.

Ownership patterns have changed radically over the years, but now appear to have stabilized. Forty years ago, in 1920, less than 10% of the forest land was in public ownership. In 1933, however, the Copeland Report[2] listed under ownership of forest lands within the Lake States region the following distribution by percentage of area:

Federal	Other Public	Total Public	Industrial	Farm	Total Private
5%	7%	12%	62%	26%	88%

From an examination of these figures, it is readily apparent that the only ownership which has remained constant over the period of 20 years is that attributed to the farm proprietor. Public ownership has increased 28%, and industrial ownership decreased 56%.

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[1]U. S., Forest Service, Timber Resource Review (Chapt. IV D), p. 43.

[2]U. S. Department of Agriculture, Forest Service, A National Plan for American Forestry, Report from Sec. of Agriculture to the Senate of the 73rd Congress, 1st session, 1933, p. 131.

In 1940 unpublished data compiled from the initial survey of 1931 showed the following ownership pattern for the region:

Federal	State	County	Total Public	Farm	Other Private	Total Private
12½%	16%	11%	39½%	27%	33½%	60½%

From the statistics of 1940, it can readily be seen that the great transition period of the 1930's in land ownership in the Lake States region had just about run its course and a period of stability had been entered.

By 1945, the commercial forest-land ownership in the Lake States had stabilized, and statistics secured from the inventory of that year are essentially the same as those for 1953, both for the region as a whole and for each state individually. Table 19, when compared with Table 18, would tend to indicate that, unless some dramatic event takes place, the wood needs of the region must be supplied by the present ownerships.

The loss of 2% in public ownership over the 8-year period (1945-53) is non-significant and could easily be attributed to changes in the classification of what constitutes commercial forest land, or to withdrawals of public property for other land uses. Farm-woodlot ownership, on a percentage basis, has changed little since 1933 and there appears to be slight reason to believe it will change in the future, except in the direction of decrease.

Table 19. Ownership of commercial forest land in the Lake States--1945

Ownership Class	State: Michigan	State: Minnesota	State: Wisconsin	Regional Total	% of Total
	(thousand acres)				
Federal	2,155	2,670	1,670	6,495	13
State	4,055	3,300	460	7,810	15
County	65	3,800	3,310	6,995	14
All Public	6,270	9,770	5,260	21,300	42
Farm	3,260	4,330	6,340	13,930	28
Industrial and Other	7,850	2,600	4,665	15,115	30
Total Private	11,110	6,930	11,005	29,045	58
Grand Total	17,380	16,700	16,265	50,345	
% Public	36	58	32	42	

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper No. 1), p. 5.

In attempting to evaluate the capabilities of the various forest ownerships, it is well to examine the average size of the holdings, for both the quality of forest management and the costs of timber harvesting will be affected by this factor. Table 20 indicates the average size holdings by private ownerships in 1953.

Table 20. Average size of private forest land ownerships in the Lake States--1953

Ownership	State: Michigan	State: Minnesota	State: Wisconsin	Regional Average
	(acres)			
Farm	31	48	45	41
Wood Manufacturing	6,950	1,540	4,450	3,750
Other Private	150	64	120	136
All Private	71	56	64	65

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper No. 37), p. 4.

The farm woodlots of the Lake States, like those of most other forest regions, although providing an appreciable total acreage, are individually small, averaging only 41 acres. This is slightly below the average of 49 acres for the United States. This acreage can and does provide a perceptible part of the raw materials for the wood-using industries of the region. However, the output is variable and often uncertain and the harvesting tends to be inefficient due to the small-sized tracts.

The "other private" element, with its greater average acreage, provides an appreciable segment of the pulpwood for the tri-state area. In Michigan, where this type ownership is largest, it is the source of slightly over 50% of the pulpwood production.[1] This proprietorship is capable of producing large volumes at regular intervals at a reasonable harvesting cost.

The public lands of the region produce far short of their potential. The federal forests, which have been operable for a longer period than the State and County areas, are a reliable source of pulpwood, and their annual cut continues to increase.

The State and County forests, principally constructed from tax-delinquent lands, are in general just now reaching the stage of productivity. Consolidation has been taking place through purchase and exchange, and administration has been improved. As a result this class of ownership is providing a constantly greater portion of the needs of the pulp and paper industry. It appears that these lands will continue to furnish increasing quantities of pulpwood, providing other conflicting

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[1]James, Marketing Pulpwood in Michigan, p. 39.

land uses do not cause their withdrawal from timber production or modify their management too radically.

Forest Types and Conditions

It is not enough to know that sufficient forest land exists to support the wood-using industries of the region; it is necessary also to be familiar with the materials being grown on it and the condition of the forest growth.

Since all species of trees are not interchangeable in the pulp-mill, it becomes necessary in an investigation of the present available volume of wood to separate it into specific utilization categories. Table 21 gives the commercial forest acreage falling into different forest types as of 1953, while Table 22 presents the same information for 1945.

Table 21. Commercial forest land in the Lake States by types--1953

Forest Type	State			Regional Total	% of Total
	Michigan	Minnesota	Wisconsin		
	(thousand acres)				
Pine	1,644	1,685	1,116	4,445	8½
Spruce-Fir	1,872	4,046	1,140	7,058	13
Tamarack	264	699	310	1,273	2½
Cedar	929	443	313	1,685	3
Total Softwood	4,709	6,873	2,879	14,461	27
Aspen	5,552	6,992	5,907	18,451	35
Northern Hardwood	5,413	986	2,909	9,308	17
Oak and other Hdwd.	3,175	3,247	4,630	11,052	21
Total Hardwood	14,140	11,225	13,446	38,811	73

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper No. 37), p. 5.

Table 22. Commercial forest land in the Lake States by types--1945

Forest Type	State			Regional: Total	% of Total
	Michigan	Minnesota	Wisconsin		
	(thousand acres)				
Pine	1,510	1,620	1,163	4,293	9
Spruce-Fir	2,069	3,220	1,280	6,569	13
Tamarack	307	980	306	1,593	3
Cedar	784	550	295	1,629	3
Total Softwood	4,670	6,370	3,044	14,084	28
Aspen	5,900	7,500	6,458	19,858	39
Northern Hardwood	4,930	1,190	3,325	9,445	19
Oak and others	1,880	1,640	3,438	6,958	14
Total Hardwood	12,710	10,330	13,221	36,261	72

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper No. 1), p. 6.

There appears to have been no significant change in the forest type-structure of the Lake States region during the period 1945 to 1953, except for the possibility of a portion of the aspen acreage having shifted into the hardwood type. With a temporary type such as aspen, this is a distinct possibility, but there is also a good chance that the percentage difference shown could be attributed to variations in the instructions between the two inventories.

In the 1938 inventory, the forest types of the region were distributed as follows:

Table 23. Commercial forest land in the Lake States by types--1938

Forest Type	Acreage (thousands)	Per Cent of Total
Pine	3,665	6
Spruce-Fir	5,480	10
Other Softwood	2,327	4
Total Softwood	11,472	20
Northern Hardwood	8,215	15
Aspen-Birch	16,672	30
Oak and others	5,492	10
Total Hardwood	30,379	55
Scrub and Deforested	13,783	25
Total	55,634	100

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station, Economic Notes, No. 10), p. 12.

It seems that the type acreages for the area are now fairly stable, and except in cases where a definite effort is made to convert them, the industry will have to depend for its pulpwood upon the present distribution.

With 35% of the forest acreage falling in the aspen type, and a total of 73% of it supporting hardwoods of various species, it can be seen why over 44% of the pulpwood produced in the region in 1959 was aspen and 54% was made up of broadleaved species.

When considering the present forest area of the Lake States region, it is well to examine the productivity classification assigned to recently cutover lands in the section. The Timber Resource Review shows that in 1953, 77% of the recently cutover lands were rated as high, 20% as medium, and only 3% as low in productivity class. This can be compared with a

national average of 65% high, 24% medium, and 11% low. Regardless of the methods of evaluating productivity which were used, if they were consistent, a comparison between regions and ownerships is valid. Table 24 shows the breakdown by ownership classes for productivity.

Table 24. Productivity of recently cutover lands in the Lake States--1947-1952

Forest Land Ownership	Productivity Class		
	High	Medium	Low
	(per cent)		
All public	80	19	1
Farm	59	29	12
All wood-using industries	93	7	0
Other private	66	25	9
All private	69	23	8
All ownerships	77	26	3

Source: Timber Resource Review (Chapter IX), p. 99.

An analysis of Table 24 indicates that the public ownerships, comprising 40% of the forest land in the region, are presently in good condition, insofar as the current and future growth in forests can be estimated from the condition of recently cutover lands. The private ownerships, however, do not present such an excellent picture, particularly in the farm and "other private" categories. These holdings, which comprise 54% of the commercial timberland of the region, have only slightly more than half of their area falling within the "high productivity" class, and over 10% of it falls within the "low productivity"

category. In 1959, it was estimated that over half of the region's pulpwood-cut came from these two ownerships. Even though, in comparison with public and industrial holdings, these ownerships seem to rate very low, both are well above the national average for their class. It appears that it is within these classes that the most improvement can be made for production in the future.

In order to evaluate the present situation for a product such as wood which is very heterogeneous, due to the many species with widely varying physical characteristics, it is necessary to examine the conditions which exist within the forest types of the region. An evaluation of recent cutting practices within the area reveals that the aspen and northern hardwoods types have 84% and 83% of their acreage falling within the "high productivity" classification. These two types make up over 50% of the commercial forest land in the region and, although of lower value for pulpwood presently, they contribute over 50% of the local production, and can be expected to contribute still more in the future.

The coniferous types, pine and spruce-fir, have 62% and 71% respectively of their acreage classified as "high productivity" while the oak-hickory type, much of which falls in the farm-ownership classification, has only 54% of its acreage falling within the "high productivity" class. This latter type still provides only a minor portion of the domestic wood used by the industry at present, but the relatively low productivity is indicative of conditions existing now which should be remedied.

Present Stands and Growth

Ascertaining that the forests of the region have been able to supply the wood-using industry of the area in the past and at present is not sufficient, for this task could have been accomplished at the expense of loss of wood capital. It becomes necessary therefore to evaluate the wood capital at present, and the growth being made upon it, in the light of the current wood-using industries dependent upon it for their support. In addition, an examination of the trend in wood capital and growth in recent years is necessary if the future capabilities of the region are to be predicted.

In the Timber Resource Review, the U. S. Forest Service attempted to estimate both forest stands and growth for the entire country in 1953. This inventory is the latest of many which have been made, and it will be used to gauge the present condition of the forest resource, and then compared with past studies to determine trend. Table 25 gives the net volume of growing stock in the region on the basis of cubic volume by species-groups and states as of 1953.

The statistics in Table 25 indicate that for the region there is a growing-stock volume of 25,218 million cubic feet spread fairly evenly among the three states. Of the volume, however, 74% falls into the hardwood category, and it is only in Minnesota, where only 60% of the growing stock is hardwood, that a species balance is found.

From Tables 25, 26, and 27, it is evident that the volume of growing stock in the region has become fairly stable overall. It is difficult to compare volumes over time, for different utilization standards can account

for wide variations.

Table 25. Net volume of growing stock on commercial forest lands of the Lake States--1953

Species	State			Regional Total	% of Regional Total
	Michigan	Minnesota	Wisconsin		
	(million cubic feet)				
Pine	682	1,225	726	2,633	10½
Spruce-Fir	710	1,172	238	2,120	8½
Other Softwood	886	432	472	1,790	7
Total Softwood	2,278	2,829	1,436	6,543	26
Aspen	1,768	1,862	1,742	5,372	21
N. Hardwood	2,091	139	920	3,150	12½
Oak-Hickory and others	3,775	2,405	3,973	10,153	40½
Total Hardwood	7,634	4,406	6,635	18,675	74
Total	9,912	7,235	8,071	25,218	100

Source: U.S.D.A. Forest Service (Lake States for Experiment Station Paper No. 37), p. 8.

Table 26. Net volume of growing stock on commercial forest lands of the Lake States--1945

Species	State			Regional Total	% of Regional Total
	Michigan	Minnesota	Wisconsin		
	(million cubic feet)				
Pine	420	980	460	1,860	8
Spruce-Fir	840	1,010	230	2,080	9
Other Softwood	2,040	410	610	3,060	13
Total Softwood	3,300	2,400	1,300	7,000	30
Aspen-Birch	1,800	2,280	1,150	5,230	22½
Northern Hardwood	2,990	160	1,440	4,590	20
Oak and other	2,210	1,060	3,110	6,380	27½
Total Hardwood	7,000	3,500	5,700	16,200	70
Total	10,300	5,900	7,000	23,200	

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper No. 1), p. 7.

Table 27. Net volume of growing stock on commercial forest lands of the Lake States—1938

Species	State			Regional Total	% of Regional Total
	Michigan	Minnesota	Wisconsin		
	(million cubic feet)				
Pine	486	1,618	581	2,685	10
Spruce-Fir	880	1,175	235	2,290	9
Other Softwoods	2,482	458	1,055	3,995	16
Total Softwoods	3,848	3,251	1,871	8,970	35
Aspen-Birch	1,112	2,138	827	4,077	16
Northern Hardwood	3,851	154	1,616	5,721	22
Oak and other	2,471	1,360	3,310	7,041	27
Total Hardwood	7,434	3,652	5,753	16,839	65

Source: U.S.D.A., Forest Service, (Lake States Forest Experiment Station, Economics Notes No. 10), p. 46.

However, it is interesting to compare the figures from the first of the modern inventories, made in 1931, with those of the present Timber Resource Review of 1953.

Table 28. Net volume of growing stock on commercial forest lands of the Lake States for selected years

Year	Cubic Volume (in Millions)	Per cent Softwood	Per cent Hardwood
1931	21,550	27	73
1938	25,809	35	65
1945	23,200	30	70
1953	25,218	26	74

It becomes apparent that the softwood component of volume is being removed at a faster rate than the hardwood segment. However, the total volume of softwood growing stock has not been heavily depleted.

The present softwood volume represents about 2% of the softwood growing stock of the nation, while the hardwood component makes up nearly 12% of the nation's broadleaf volume; the same proportion that each did in 1931. The total growing-stock of the region comprises 5% of that of the entire country, as it did in 1931. Coincidently the volume of growing stock removed for forest products is 5% of the national cut, and this is divided so as to provide 2½% of the softwood cut and 11½% of the hardwood removal.

It is well to consider the ownership of the presently available volume, for upon it will depend, to a large extent, the sales and management policies so important to dependent industries. Table 29 gives the volume of growing stock by major land ownerships within the region.

Table 29. Net volume of growing stock on Lake States forests by ownership classes--1953

Ownerships	States						Total	% of Total
	Michigan		Minnesota		Wisconsin			
	cu vol	%	cu vol	%	cu vol	%	cu vol	
	(volumes in thousand feet)							
National Forest	1,119	11	1,367	19	713	9	3,199	13
All Federal	1,183	12	1,769	24	1,316	16	4,268	17
State	1,511	15	1,213	17	229	3	2,953	12
County	49		1,070	15	853	11	1,972	8
All Public	2,743	27	4,052	56	2,398	30	9,193	37
Farm	2,283	23	1,992	28	3,376	42	7,651	30
Other Private	4,886	50	1,191	16	2,296	28	8,374	33
Total Private	7,169	73	3,183	44	5,673	70	16,025	63

Source: U.S.D.A., Forest Service (Lake States Forestry Experiment Station Paper No. 37), p. 9.

It is quite evident, from an examination of Table 29, that Minnesota presents a different pattern from either Wisconsin or Michigan. With 56% of both acreage and growing stock in public ownership, it is apparent that industry will be dependent to an appreciable extent upon public timber-sales policies and management objectives in Minnesota. In the other two states, where both public acreage and growing stock form only 30% of the state totals, private-land policies are more important at present.

The net annual growth of the growing stock in the region will eventually set the annual cut, if sustained operation is to be the goal. Realizing that the tri-state area is still largely in a relatively early stage of forestry development, and that it has in no way approached its capabilities, it is still important to examine the growth figures and compare them with what is being removed. Table 30 gives the estimated net annual growth of growing stock on commercial forest lands in the region in 1952.

An inspection of Table 30 calls attention to the fact that, for the region as a whole, there is a net current annual growth of 1,180 million cubic feet of which 73% is hardwood and 27% softwood. It appears that in the short-term future, if cutting is to be held in line with growth, 30% of the annual cut should fall in the softwood category and 70% should be taken from the hardwood component.

Table 30. Net annual growth of growing stock on commercial forest lands of the Lake States—1952

Species	State			Regional Total	% of Regional Total
	Michigan	Minnesota	Wisconsin		
	(million cubic feet)				
Pine	70	30	39	139	12
Spruce-Fir	41	66	15	122	10
Other Softwood	24	22	12	58	5
Total Softwood	135	118	66	319	27
Aspen-Birch	94	184	126	404	34
Northern Softwood	50	6	21	77	7
Other Hardwood	154	77	149	380	32
Total Hardwood	298	267	296	861	73
Total	433	385	362	1,180	100

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper No. 37), p. 15.

It appears that growth in the region like growing stock, has not changed greatly on a percentage basis over the past twenty years. However on a volume basis, there are indications that growth has almost doubled. It is well to use caution in analysing any comparative growth figures, however, for differences may be due to variations in inventory instructions or definitions. The Copeland Report (1931) placed the current annual growth for the three states at 644 million cubic feet, of which 26% was softwood and 74% hardwood. This growth was equivalent to 7% of the national total. Table 31 gives a summary of the annual growth as shown by the four recent inventories of the region.

Table 31. Net annual growth of growing stock in the Lake States--1931-1953

Year	Species			Regional Total
	Softwood	Aspen	Hardwood	
	(million cubic feet)			
1931	167	477		644
1936	248	329	401	984
1945	178	336	298	812
1953	319	404	457	1,180

From Table 31, it appears as though the cubic volume of current growth for the region is stabilized at 27% softwood and 73% hardwood. It is apparent also that even though the current growth is increasing, it still remains very low for the region as a whole, averaging only 22 cubic feet per acre per year, or on a cord basis barely over ¼ cord.

From a perusal of Tables 21, 25, and 30, it is now possible to determine whether acreage, growing stock, and net annual growth are consistent on a percentage basis by forest types.

Table 32. Percentage of acreage, growing stock, and net annual growth on Lake States forests by species groups--1953

Species	Basis			1952 Timber Cut
	Acreage	Growing Stock	Annual Growth	
	(percentage of regional total)			
Pine	8½	10½	12	12
Spruce-Fir	13	8½	10	13
Other Softwood	5½	7	5	10
Total Softwood	27	26	27	35
Aspen	35	21	34	24
Northern Hardwood	17	12½	7	17
Other Hardwood	21	40½	32	24
Total Hardwood	73	74	73	65

Table 32 indicates, for the region as a whole, a very consistent relationship between acreage, growing stock, and net annual growth at present. When the last column, the percentage of total timber cut from each species group, is examined a discrepancy appears. Here, it is evident that on the basis of percentage, the softwoods are providing too large a share of the present cut and the hardwoods too small a share. The unbalanced condition is especially evident in the case of the "other softwoods" and "other hardwoods" components. Table 33 indicates the situation by states in respect to the volumes cut in 1952.

Table 33. Timber cut from growing stock on commercial forest lands of the Lake States--1952

Species	State						Regional Total	
	Michigan		Minnesota		Wisconsin			
	million cu ft.	%	million cu ft.	%	million cu ft.	%	million cu ft.	%
Pine	11.2	5	36.1	24	16.9	10	64.2	12
Spruce-Fir	22.3	10	37.0	25	9.2	5	68.5	13
Other Softwood	33.5	16	5.4	4	16.9	10	55.8	10
Total Softwood	67.0	31	78.5	53	43.0	25	188.5	35
Aspen	38.0	18	42.8	29	47.2	27	128.0	24
Northern Hardwood	62.0	29	3.6	2	27.0	16	92.6	17
Oak and other	48.5	22	23.2	16	56.3	32	128.0	24
Total Hardwood	148.5	69	69.6	47	130.5	75	348.6	65
Total	215.5		148.1		173.5		537.1	

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper No. 37), p. 22.

When Table 33 is inspected, it is readily apparent that the present cuts from the states of Michigan and Wisconsin are in fairly good balance with acreage, growing stock and growth by species, when expressed on a

percentage basis. However, it is obvious that in Minnesota at present the softwood stands are providing too large a proportion of the cut.

Present Growth, Drain, and Industrial Needs

The present wood-using industry of the Lake States is in a state of flux. The two primary users of round wood are the lumber and the pulp and paper mills, and each uses a large volume of domestically-produced timber as well as a considerable volume of imports. It appears as if the lumber industry is now stabilized at an annual volume of 200 million cubic feet, while the pulp and paper industry which in 1959 used 240 million seems to be still increasing its requirements.

In 1952, it was estimated that 537 million cubic feet of Lake States timber was used to support the local dependent industries. Of this total, 71% was used by the lumber and pulp and paper industries, with each using about half of the volume. Since that time the pulp and paper industry has exceeded the lumber industry in the use of domestic round-wood. Table 34 gives the major uses, by volumes and percentages, for 1952 and 1954.

Table 34. Consumption of Lake States timber by local users--1952-1954

Uses	1952 Volume		1954 Volume	
	million cu ft.	Per cent of total	million cu ft.	Per cent of total
Lumber	195	36	168	35
Woodpulp	179	35	180	37½
Fuelwood	104	18½	79	16½
Veneer-cooperage	14	2½	16	3½
Poles-piling posts-props	25	4½	20	4
Miscellaneous	20	3½	17	3½
Total	537	100	480	100

Sources: 1. U.S.D.A., Forest Service, Timber Resource Review (Chapt. IX), p. 76.

2. U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper, No. 53), pp. 24-37.

Of the domestically-produced wood used in the region, a volume of 188 million cubic feet (35%) was softwood while 349 million cubic feet (65%) of the cut was hardwood. The 1948 cut by species-groups was the same on a percentage basis, even though the volume of 675 million cubic feet was almost 150 million greater than that removed in 1952. For the period 1930 to 1945, the domestic volume used fluctuated about the 650 million-cubic-foot mark.

For the three states comprising the region, there appears to have been little change during the period 1948 to 1954 relative to the percentage each supplied of the total timber volume. Michigan provided about 41% of the material, while Wisconsin and Minnesota furnished 31% and 28% respectively.

In 1947, the regional wood-using industry was estimated to contain 5,800 processing plants, employing 130,000 persons (exclusive of woods workers), paying over $100 million in wages, and turning out products worth over $3/4 billion. It is interesting to compare the percentage of plants in each state with the percentage of the volume of wood supplied by each.

Table 35. Number of wood-using plants in the Lake States--1947

Industry	Regional Plants	State		
		Minnesota	Wisconsin	Michigan
		(per cent)		
Sawmills	5,200	29	34	37
Pulp and Paper	147	12	50	38
Veneer	85	9	65	26
Miscellaneous	368	Not Available		
Total	5,800			

On a percentage basis, it appears that the volume of domestic sawtimber provided by each state is correlated closely with the number of plants within its boundaries. This is to be expected, because sawlogs are not, generally, transported long distances due to the migratory character and small-size of the mills using them. On the other hand, the pulp and paper industry, with its more dynamic growth and large capital investment, imports considerable volumes of wood. This shows up particularly in the case of Minnesota, which in 1947 had only 12% of the plants, but provided 42% of the wood for the industry. However considering trends, it is interesting to note that in 1959, twelve years later, Minnesota was producing only 33% of the roundwood and Wisconsin had

raised its share of the regional output to 32%. This trend is indicative of the growing realization within the industry of the need to grow wood rather than to transport it.

In considering the present needs of the wood-using industries of the region, it is well to concentrate upon the lumber and pulp and paper trades which consume over 70% of the area's output. It is evident that even though the less important products consume substantial quantities of round wood and refuse, the general trend in their production is downward. Arthur Horn, in his appraisal of timber cut from the forests of the Lake States in 1954, pointed out the following trends:[1]

Table 36. Cut of minor forest products from the forests of the Lake States--1935-1954

Product	Unit of Measure	Production 1935-44	Production 1954	% change
Fuelwood	Million cords	7 1/3	3	-60%
Fenceposts	MM pieces	32	24	-25%
Mine Material	M cords	165	70	-60%
Poles and Piling	M pieces	400	190	-50%
Cooperage logs	M BM	1,500	700	-50%
Chemical Wood	M cords	220	146	-33%
Excelsior	M cords	60	70	+15%

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper No. 53), p. 13.

Table 36 indicates a decline in the use of all of the minor products except excelsior which, over the more recent period of 1946-1958

[1] Arthur G. Horn, A Record of the Timber Cut from Forests of the Lake States - 1954 (Lake States Forest Experiment Station, Station Paper No. 53), (Sept., 1957), p. 13.

averaged 80.2 thousand cords. However, it has been subject to wide fluctuations in the past with annual cuts varying from 53 thousand to 95.5 thousand cords.[1] Since almost all of this cut is made up of aspen, which is at present in good supply, it appears that the minor wood products may be ignored when considering competition for the available domestic supply of timber currently.

The sawtimber industry of the region seems to have stabilized at about the 1 billion board-foot mark, after having sunk to a low of less than 300 million in 1932. During the period 1935-1944 this was the average annual cut, and except for the war years when it reached 1-1/3 billion board feet, it has continued to fluctuate about this volume. In 1954, of the 863 million board feet produced in the Lake States as sawlogs and sawbolts, 31% was softwoods and 69% hardwoods. Almost all of this volume was used in the state in which it was produced, and although considerable volumes of sawtimber have entered the import-export trade between the three states in the past, the trend is for a steady decline in this movement. A slow decline will probably take place in the output of the sawtimber industry unless more modern mills and equipment are used to make it competitive.

The pulp and paper industry within the region appears to be increasing at a rate, which although not spectacular has been steady. In 1959 the three million-cord mark was topped for the first time with 3,393 thousand cords having been received by the local mills. Of this total

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[1]U. S. Department of Agriculture, Forest Service, Technical Notes (Lake States Forest Experiment Station, 1946-1958).

3,020 thousand cords, or 89% was produced within the tri-state area, and only 11%, mostly spruce, was imported. This is in contrast to 1955 when almost 19% of the receipts were imported, 1949 when the percentage was almost 28%, and 1941 when it was over 30%. Here then is evidence of a definite trend downward in the imports of pulpwood from outside the region.

Wisconsin is the only one of the regional states which is a net importer of area-produced wood. In 1959, 43% of the regionally-produced wood received by Wisconsin mills was imported. In 1955, this figure was 50%, while in 1949 it was again 43%. Little trend is apparent here, and it appears that about 45% of the Wisconsin consumption of regionally produced wood will continue to come from Michigan and Minnesota, which are both net exporters. In 1959, Michigan's exports of pulpwood exceeded its imports by 354 thousand cords, while the net export figure for Minnesota was 181 thousand cords. Most of this export wood went to mills in Wisconsin.

It appears that there has been relatively little change in the overall wood-using-industry requirements of the region since the Timber Resource Review made its inventory in 1952. At that time, it was estimated that the use of domestically-produced wood would fluctuate in the vicinity of 650 million cubic feet and that the total wood-needs would not exceed 750 million cubic feet. Since 1952, the pulp and paper industry has increased its wood consumption 22%, while the lumber industry has remained fairly steady at the 200 million cubic-foot mark. However, the minor forest-product uses have, in general, all decreased their utilization during this period, and this is largely responsible for the

overall consumption remaining constant. As an example, the use of wooden mine-materials decreased 50% during the period 1952 to 1958, and of the volume consumed the percentage of softwood dropped from 69 to 63.[1]

It remains now to compare the present needs of the wood-using industry of the region with both the volume of growing stock available and the current net increment being placed upon it. Table 37 indicates this relationship.

Table 37. Annual industrial consumption, net annual growth and net growing stock - Lake States - 1953

	Total	State		
		Michigan	Minnesota	Wisconsin
Estimated	(million cubic feet)			
Industrial Consumption	550	N.A.	N.A.	N.A.
Annual Growth (Net)	1,180	433	385	362
Net Growing Stock	25,218	9,912	7,235	8,071

Sources: Timber Resource Review (1955), Technical Notes (Lake States Forest Experiment Station (1958-59).

From Table 37 it is evident that the present needs of the wood-using industries could easily be fulfilled from local sources without depleting the resource. The presence of a net annual growth of 1180 million cubic feet, which exceeds the current total consumption of the region by 630 million cubic feet, or 115%, is indicative of the present

[1] U. S., Department of Agriculture, Forest Service (Lake States Forest Experiment Station, Technical Note No. 570, Oct., 1959).

situation within the tri-state area relative to the growth and drain of timber.

It is not sufficient, however, to analyse the overall relationship only, because shortages within certain species-groups have led the industries to seek wood outside of the region. For the area as a whole, the wood-using industries have been obtaining 65% of their consumption from the hardwood component, while the remaining 35% has been made up of softwoods. However, it is noticeable that within the pulp and paper industry almost 52% of the utilization in 1959 was still softwoods. Despite the fact that this percentage has decreased from 73% in 1949 and 57% in 1955, it is evident that if the industry is to be locally supported there must be a greater use made of the hardwood element of the growing stock. The lumber industry, which is the primary competitor of the pulp and paper industry for the available stumpage, obtains almost 70% of its consumption from the hardwood component.

If the total use is assumed to be 550 million cubic feet, and if 40% of this is assumed to be softwood, the present annual needs of the wood-using indusries are 220 million cubic feet of softwoods and 330 million cubic feet of hardwoods. The region is, at present, growing approximately 320 million cubic feet of softwoods and 860 million cubic feet of hardwoods, so that the present industry could be regionally supported on present net growth alone.

Despite the fact that the present differential between growth and drain of softwoods is small, it is apparent that a surplus exists. With the present trends in species use and product modification continuing, the current wood-using industry of the region should be capable of being

supported by local production perpetually, providing no radical changes take place in the commercial forest land ownership, and in the policies of the major land owners relative to timber production.

The possibilities for expansion of the wood-using industries are good, and these will be discussed in the next chapter.

IX. CAPABILITIES OF THE LAKE STATES TO SUPPORT WITH LOCAL WOOD AN EXPANDING PULP AND PAPER INDUSTRY

Recognizing that a region is capable of supporting its present wood-using industry with local timber is not enough if the area is to maintain a dynamic outlook. It is necessary that consideration be given not only to the demands of existing industries, but also to the projections of future needs and plant expansion, as well as to the capacity of the forest area to produce.

It must be realized that not only is the industrial picture of the region changing, but also that the condition of the forests is altering greatly. Some of the forest modifications are strengthening the timber economy while others are having the opposite effect. M. B. Dickerman in his analysis of the Lake States forest situation summarized the most significant points as:

1. The thickening up of the forest stands in recent years.
2. The presence of a sizeable area of deforested land.
3. The expanding reforestation program.
4. The stabilized ownership pattern.
5. The favorable outlook for aspen.
6. The concern about maintaining conifers.
7. The expanding supply of oak.[1]

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[1] M. B. Dickerman, The Changing Forests of the Lake and Central States Region (U. S., Department of Agriculture, Forest Service, Lake States Forest Experiment Station, Misc. Report, No. 31, 1954), p. 10.

To these might be added the attainment of pulpwood size of many of the coniferous plantations made during the C.C.C. program, the rapid emergence of competing uses for forest land, and the fact that farm-woodlot management practices have improved but little.

Consideration of the points listed above elicits the question, how do present forest trends compare with projected needs? The presence of a surplus of cubic-volume growth over actual cut within the region reveals the possibilities for expansion of the wood-using industries, especially those capable of utilizing cordwood-size material. Frank Bennett in a discussion of timber surpluses said,

> Surpluses are bad only if they are to remain surpluses. On the other hand timber surpluses are good if they are accepted by industry as a challenge to do something about them.[1]

The 52 million acres of commercial forest land in the Lake States can more than support the present regional industry, and in addition they fulfill the requirements of accessibility, productivity and economy of reproduction. They are capable of producing greatly expanded volumes of wood if properly managed. Prognoses indicate that this wood will be needed. Additional timber production will mean an increase in jobs, products, and prosperity for the region, but only if the increased production is used.

The problem of the utilization of available forest resources was recognized in 1940 in a statement prepared by the paper and pulp industry in response to the Joint Resolution of the 75th Congress providing

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[1] Frank W. Bennett, "A Look Ahead," Forests and People, Vol. II, No. 1 (1961), p. 20.

for the study of the forestry situation in the United States, when the assertion was made that:

> To a very large extent the solution of the forest land use problem in the Lake States must come from a wider use of the resource by industry . . . the major problem is not, at the moment at least, one of expanding growth to some point more closely approximating the potentialities. It is, again, one of developing uses for much of the material that is on the ground and that is growing . . . A most urgent need in forestry is use. Extension of use means a greater and more stable flow of forest commodities and services to consumers; it also means a greater employment of labor, capital, and business organization. To secure these benefits wood-use must maintain and expand its place in a far-reaching competition.[1]

Throughout the growth of forestry in the United States, based as it was originally upon conservation, has always flown the undercurrent of non-use or saving for the future. It is gratifying to see today the forester and industry joining hands to foster the belief that forests must be used. With this doctrine comes a dual responsibility. Industry must expand its production and uses to provide a market for the forest products, and the forester must grow sufficient wood as efficiently as possible. This will insure that price increases, due to scarcity of raw materials, will not occur and lead to the curtailment of demand for the ultimate products. It will also insure the consumer of a steady supply of quality products at a price he can afford to pay.

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[1] American Paper and Pulp Association, Forest Industry and National Forest Economy. A Statement in Response to the Joint Resolution of the 75th Congress (January, 1940), p. 31.

Future Regional Production of Forest Products

In Chapter II it was evident that there was a wide variation between prognoses of the future consumption of paper and board products for the years 1975 and 2000. Still it becomes necessary in a growth industry, such as pulp, paper, and board, to attempt to predict future consumption and the average rate of its increase or decrease.

Estimates of the consumption of paper and board for the year 1975 vary from 53.5 to 64.2 million tons. This increase is at a compound rate fluctuating from 2.3% to 3.4% over the 15-year period (1960-1975). Over the longer prediction-period of 40 years (1960-2000), in which the prognoses varied from 95 million to 240 million tons, the compound rate of increase fluctuated from 2.3% to 4.6%. Although it is dangerous to predict future consumption when it hinges on so many variables, it appears that a rate of 3% could be maintained by the industry for the next 15 years, providing it preserves its dynamic outlook.

In 1959, the Lake States region produced 14.4% of the total paper and board products manufactured in the United States. This percentage, like the percentage of woodpulp produced within the area, has been declining. It is expedient at this point to determine the size of the production which the regional industry must be ready to assume in the years 1975 and 2000, if it is to maintain its competitive position. It is also well to consider the possibilities of expanding production at the expense of competing regions.

The tri-state output of paper and board in 1959 was 4.9 million tons, and if the region is to maintain its present position nationally,

this output will have to be expanded to 7.7 million tons by 1975 and 16 million tons by the year 2000. Both figures were arrived at by assuming a compound growth rate of 3% for the two periods.

If the paper and board industry of the area is to operate on a domestic supply of woodpulp, it will be necessary that the wood-pulp producing capacity be increased to 5.6 million tons by 1975 and 11.6 million tons by the year 2000. The future capacities needed for wood-pulp production are based on the assumptions that (1) the future paper industry of the region will be supported by locally produced woodpulp, and that (2) the grade proportions will remain the same as at present. Neither assumption is without its loopholes, and it is probable, for the Lake States region, that "grade shifting" in the future will lead to a smaller input of woodpulp per ton of paper and board output, and that no attempt will be made to make the industry entirely dependent on local wood supplies.

It now becomes necessary to translate the future wood-pulp consumption into terms of pulpwood. In 1959, 3.4 million cords of pulpwood were received by mills within the tri-state area. This input was used to support a woodpulp capacity of 3.1 million tons. If the industry is to grow and also become regionally supported in respect to wood consumption, it will be necessary for the forests of the region to supply annually over 6 million cords of pulpwood by 1975 and 12 million by the year 2000. Converting these figures into cubic volume, it becomes apparent that for a sustained production it will be necessary for the forests of the area to grow, by 1975, 500 million cubic feet, and by the year 2000, 1 billion cubic feet of wood to support the pulp

and paper industry alone.

Assuming that the percentages of softwoods and hardwoods used will continue at their present ratio, the 1975 prognosis would necessitate the annual growth on regional forests of 255 million cubic feet of softwoods and 245 million cubic feet of hardwoods. For the year 2000, the required annual growth, to maintain the pulp and paper industry, would be 510 million cubic feet of softwoods and 490 million cubic feet of hardwoods.

Past trends, however, indicate that the current ratio of 51% softwoods to 49% hardwoods will continue to change in favor of more hardwood use until the proportion more nearly approximates that of the present growth and growing stock. This relationship is now 73% hardwoods and 27% softwoods, and it is expected that a 70%-30% ratio could be maintained perpetually.

If the 70%-30% ratio is assumed as a realistic indication of future use by the industry, the required growth by species-groups then becomes, for 1975, 350 million cubic feet of hardwoods and 150 million cubic feet of softwoods. For the year 2000, the annual growth would have to be 700 million cubic feet of hardwoods and 300 million cubic feet of softwoods in order to sustain the industry.

To this point, no consideration has been given to the necessity of sustaining the other forest industries of the region which are dependent to a large extent upon a local wood supply. Of these, the lumber industry is the greatest user, and the one which will provide the pulp and paper industry with the most competition for the available stumpage. Between them they account for 73% of the local wood consumed for all uses.

It is expedient to examine the condition of the lumber industry within the region and to attempt to predict its future course and convert that future into terms of raw material needed to sustain it.

The lumber industry of the region currently uses about 200 million cubic feet of raw material, most of which comes from forests within the tri-state area. Of this total, 30% is made up of softwoods and 70% of hardwoods. The input of 200 million cubic feet for the lumber industry of the region is approximately 3% of that for the continental United States.

The apparent consumption of lumber in the United States is now at the 40 billion board foot level, and has remained at about that point since 1940. Per-capita consumption, except for the war years, seems to have stabilized at 230 board feet. To fulfill the annual demand for lumber 6½ billion cubic feet of roundwood are consumed. The national production for 1975 is estimated at 44.6 to 46.0 billion board feet, a compound growth rate of only 0.8%, while the 55 billion board feet estimated for the year 2000 provides a growth rate of only 0.6% for the longer period.[1]

Applying the predicted rates of increase to the lumber industry of the Lake States region would place the area production in 1975 at 1.13 billion board feet, and in the year 2000 at 1.27 billion. To supply the predicted output from local wood supplies would take a volume of 225 million cubic feet in 1975 and 250 million in 2000.

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[1]Stanford Research Council and U. S., Forest Service, Timber Resource Review.

The future use of timber for "all other purposes" is expected to decline. Despite the fact that a rise is predicted in the production and consumption of veneer, it is more than balanced by a decline in the utilization of such minor products as fuelwood, cross ties, posts, and poles. For the region then, it is anticipated that the volume of local roundwood needed to sustain the minor wood-using industries will not rise during the periods 1960 to 1975 and 1975 to 2000.

In summary then, it appears that the region must plan, at a minimum, to grow 825 million cubic feet of roundwood by 1975, and 1.35 billion cubic feet by 2000, if it is to sustain its local wood-dependent industries. This assumes, of course, no increase in the percentage of the national consumption garnered by its two greatest users, the pulp and paper and the lumber industries. Table 38 indicates the minimum needs of the region if it is to sustain its own wood industries in the future.

Table 38. Future demand on Lake States forests if domestic industries are to be sustained - 1975 and 2000

Year	Industry			Regional Total
	Lumber	Pulp	Other	
	(million cubic feet)			
1960	200	250	100	550
1975	225	500	100	825
2000	250	1,000	100	1,350

If the percentage utilized by species in the next 15-year period (1960-1975) approaches the ratio based upon the acreage occurring in the various types now, it will be necessary for the region to supply, by growth, 575 million cubic feet of hardwoods and 250 million cubic feet of softwoods annually by 1975. For the longer period of 40 years (1960-

2000), a cubic volume of 945 million cubic feet of hardwoods and 405 million cubic feet of softwoods would have to be grown annually by 2000 if forest capital was not to be depleted.

Table 39 compares present growth within the region, as estimated in 1953, with the predicted needs in 1975 and 2000 by species groups.

Table 39. Growth and estimated drain of Lake States timber for all purposes--1975-2000

Year	Species: Hardwoods	Species: Softwoods	Regional Total
	(million cubic feet)		
Net Current Growth 1953	861	319	1,180
Consumption Year 1975	575	250	825
Deficit or Surplus	+286	+69	+355
Consumption Year 2000	945	405	1,350
Deficit or Surplus	-84	-86	-170

From a perusal of Table 39 it can be seen that, despite their relatively low productivity and their low density of stocking, the forests of the region are presently providing by growth more than enough volume to support the predicted industrial capacity in 1975.

Granted that the assumption that the percentage of hardwoods used will approach 70% may be in error, it is justified by the trend in the

use of pulpwood, the most dynamic wood use in the region.

The surpluses shown for the year 1975 in both hardwoods and softwoods indicates capacity for expansion. Conceding that the growth might not be well distributed throughout the region, and that it might not be present in the most desirable species or locations, it is nevertheless a fact that a surplus does exist now and, unless some catastrophe befalls, will exist in 1975. It appears, therefore, that the one really dynamic forest industry in the region, the pulp and paper trade, could well afford to consider expansion within the tri-state area in its plans for the future. Such plans might lead to a full use of the productive capacity of the regional forests, and once again make the wood-using industry one of the most important in the area.

Future Regional Forest Growth

Forty years ago, in 1920, three questions were posed by Clapp and Boyce in regard to the Lake States timber resource. It is of interest to note that as of today the questions have still not been answered, and an attempt will be made in this chapter to provide some solution to the problems which they propound. In their bulletin, How the United States can Meet its Present and Future Pulpwood Requirements, the authors asked:

1. What is the possibility of making up from our own forests the volume of imports?
2. What is the possibility of the region enlarging its already well-developed industry?
3. What is the size of the industry which can be maintained permanently in the future.[1]

[1]Earle H. Clapp and Charles W. Boyce, How the United States Can Meet its Present and Future Pulpwood Requirements (U.S.D.A., Department Bulletin, No. 1241, 1924), p. 44.

To answer these questions, it is necessary to consider future drain by the industry, future competition for available stumpage by other forest industries, future competition by other forest uses for the available land resource, possible technical changes, and lastly, and probably of the greatest importance, future attainable growth of wood.

D. C. Everest in a talk at the annual meeting of the Society of American foresters at Milwaukee, Wisconsin in 1954 stressed the importance of the last consideration to the industry when he said:

> To a large extent the long-range decisions that the pulp and paper industry must make will be based on the calculated capabilities of any area to provide a sustained volume of raw materials. The future of any plant will depend on the timber growing within a territorial radius dictated by freight rates that will permit competitive manufacturing.[2]

It is not enough to consider only the timber currently growing within the area, but it is of greater value to estimate the timber-growing potential of the procurement zone. Each additional cord grown and purchased close to the mill has the effect of lowering the average freight rate of the wood, thereby allowing for a saving which could be divided between the land owner and the manufacturer.

The problem of reaching the timber-growing potential is a two-fold one. The first deals with wood utilization and is a question for industry to answer. Three factors are of concern under this problem:

1. The uses of standard wood products must be maintained and preferably increased.

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[2]D. C. Everest, "Problems and Potentials of the Fibre Industry: As Related to Northern Forests," Proceedings of the Society of American Foresters (Annual Meeting, 1954).

2. New uses must be developed to utilize the presently inferior species.

3. New methods must be developed so that a greater percentage of available wood is utilized and less waste occurs.

The second part of the problem deals with forest production and the answer is put squarely up to the forester and landowner. This problem logically divides itself into two segments: (1) the securing of adequate reproduction, and (2) the investment in forest-cultural costs to secure something approaching maximum economic production.

To bring about a solution of either segment of the problem will demand an investment by either industry or the landowner. For industry, it will take the form of expenditures for research concerning the three factors cited. For the landowner, it will take the form of outlays for the purposes of planting or more intensive silvicultural operations.

Ernest M. Gould, Jr., in discussing the management of the Harvard Forest pinpointed the landowner's problem when he stated:

> Although imperfect knowledge about the course of future events is not unique to forestry, the long production period needed for forest crops makes the problem of uncertainty so central to forest management decisions that it is of necessity receiving more serious consideration as the population pressure on resources leaves less and less room for trial and error methods.[1]

In order to evaluate the capabilities of a region, it is first necessary to segregate the available forest land into its potential productivity classes. For this purpose broad site classes will be used for each of the major forest types in the area. Table 40 gives the breakdown

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[1]Ernest M. Gould, Jr., Fifty Years of Management at the Harvard Forest (Harvard Forest Bulletin, No. 29, 1960), p. 6.

for commercial forest land within the region as of 1945.

Table 40. Site classification - area of commercial forest land by type and site--1945

Forest Type	Good Site	Medium Site	Poor Site
	(thousand acres)		
W. Pine	103	392	132
R. Pine	102	302	112
J. Pine	474	1,608	1,007
Spruce-Fir	522	2,035	937
Spruce	436	1,644	995
Tamarack	162	1,002	429
Cedar	320	992	317
All Softwood	2,119	7,975	3,990
Aspen	3,031	10,627	6,200
N. Hardwood	1,716	4,847	2,882
Oak	710	1,740	1,495
All Other	560	1,612	841
All Hardwood	6,017	18,826	11,418
ALL TYPES	8,136	26,801	15,408

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper No. 1), p. 27.

Table 40 gives a picture of the productivity of commercial forest lands within the region, and to these data will be applied yield figures which could be attained under fairly intensive forest management. (For the breakdown by states, see Table 5 in the Appendix).

Yield Information - Conifers

White Pine

Fully stocked white pine stands in Wisconsin showed the following volumes at 70 years of age:

Site	Yield (cu. feet) (peeled)	Average Diameter (inches)	Average Height (feet)	Mean Annual Increment (cu. feet)
Good	10,570	11	91	151
Medium	8,470	10	77	121
Poor	6,300	8	64	90

Source: U.S.D.A., Forest Service, Second Growth White Pine in Wisconsin (Lake States Forest Experiment Station, June, 1930).

Volumes were cited in cubic feet, so that they could be converted into either board feet or cords.

Red Pine

Well stocked stands (not fully stocked) of unmanaged red pine in Minnesota exhibited the following growth rates and volumes at 60 years of age:

Site	Yield (cords)	Average Diameter (inches)	Average Height (feet)	Mean Annual Increment (cords)
Good	62	10.7	69	1.03
Medium	42	8.7	60	0.70
Poor	29	6.8	46	0.48

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station, Circular No. 778).

In addition to the volumes shown above, pulpwood thinnings on well-stocked and spaced plantations and natural stands at age 30 years produced 3 to 6 cords per acre, depending upon the site and spacing.

Jack Pine

Fully-stocked unmanaged stands of jack pine in the Lake States showed at 40 years of age the following growth and yields:

Site	Yield (cords)	Mean Annual Increment (cords)
Good	28-32	0.75
Medium	22-25	0.59
Poor	14-16	0.38

Sources: U.S.D.A., Forest Service (Lake States Forest Experiment Station Paper No. 7, May, 1947).

U.S.D.A., Forest Service (Lake States Forest Experiment Station, Technical Bulletin No. 863).

In addition to the volumes shown above, research has indicated a thinning can be made at 30 years of age in which 4 cords of pulpwood can be removed from the average acre.

White Spruce and Balsam Fir

These species seldom form pure stands within the region, but occur as components of the spruce-fir type with black spruce and various hardwoods. The spruce-fir type within which these species occur is an important pulpwood complex of high value. It is readily apparent that, despite the fact that the growth rate is often only moderate, this forest community should be subjected to intensive management practices.

As an indicator of future yields from the white spruce plantations, which have been part of the artificial reforestation program of the region for the past 30 years, it was found that in Nova Scotia at age 60 years, this species was capable of growing 55 cords of wood with the height of the average tree being 60 feet and its diameter 9 inches. This

was a mean annual rate of growth of 0.91 cords.[1] On the Petawawa plantations, a mean annual growth of from 40 to 60 cubic feet per acre was maintained over periods of from 25 to 30 years.[2]

Bowman in his work in this type found that in fully stocked, evenaged, unmanaged stands in Michigan the following results could be expected at age 60 years:[3]

Site	Yield (cu. feet) (peeled)	Average Diameter (inches)	Average Height (feet)	Mean Annual Growth (cu. feet)
Good	2,400	5.1	55	46
Medium	2,000	4.3	44	38
Poor	1,290	3.6	33	25

He also indicated that in unevenaged, unmanaged stands with a basal area exceeding 60 square feet, a current annual increment of 50 cubic feet could be maintained, and as the basal area increased it could be brought up to the one-cord figure.

Black Spruce

Yields measured at 60 years of age on fully-stocked black spruce stands in northeastern Minnesota exhibited the following characteristics:

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[1]U. S. Department of Agriculture, Forest Service (Lake States Forest Experiment Station, Station Paper No. 55, November, 1957).

[2]Ibid.

[3]A. B. Bowman, Growth and Occurrence of Spruce and Fir on Pulpwood Lands in Northern Michigan (Michigan State College, Technical Bulletin No. 188, January, 1944), pp. 16 and 76.

Site	Yield (cords)	Average Diameter (inches)	Average Height (feet)	Mean Annual Increment (cords)
Good	32	5.5	44	0.53
Medium	22	4.5	37	0.37
Poor	6	3.3	29	0.10

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station, Silvical Characteristics Series, Station Paper No. 45).

Black spruce is seldom cut for any purpose other than pulpwood, and so the volumes and growths are shown in cords of merchantable unpeeled wood. It is obvious that this species should, if possible, be maintained at a high level of production, for it is extremely valuable for pulpwood, and it is one of the few economically important trees capable of utilizing the vast areas of peat swamps in the region.

In addition to the swamp areas of reasonably pure black spruce, this species provides about 10% of the volume within the spruce-fir and jack pine types.

Tamarack

Recent forest surveys in Minnesota indicate that tamarack, which was severely damaged by the sawfly epidemic between 1910 and 1930, has recovered, and will soon be in a position to add substantially to the volume of pulpwood, posts, and mine timbers used in the region. From a perusal of the Minnesota figures, it is estimated that the mean annual growth on average sites is now 0.29 cords, on stands of empirical stocking.[1]

[1] U.S.D.A., Forest Service, Resurgence of Tamarack in Minnesota (Lake States Forest Experiment Station, Technical Note, No. 397, April, 1953).

It has been found that with good stocking on average sites, a yield of 35 cords per acre can be attained in 70 years, giving a mean annual increment of 0.5 cords. This shows the tremendous effect of density of stocking on final yield.

White Cedar

This species occurs both pure and in combination with the spruces, fir, and tamarack in coniferous swamps. Due to the great increase in deer population, reproduction of this component of the swamp type is becoming difficult to obtain. As a result, cedar like hemlock is providing a smaller portion of the new crop.

Cedar, at present, is of little direct interest to the pulp and paper industry, but it does provide some material for the lumber and miscellaneous round-wood industries, thereby making a greater volume of other softwood species available for the manufacture of wood pulp.

Where cedar has grown as a fairly pure type, volumes at 80 years of age on good sites have averaged 4,200 cubic feet per acre, in trees 54 feet high and 8.7 inches in diameter. However, on the poor sites, at the same age, there was a volume of only 1,620 cubic feet, in trees averaging 15 feet in height and 3.3 inches in diameter.[1] For the average site this would give an approximate mean annual increment of 36 cubic feet.

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[1] U. S. Department of Agriculture, Forest Service (Lake States Experiment Station, Station Paper No. 67, July, 1958).

Softwood Capabilities Under Fairly Intensive Forest Management

It now remains to multiply the available land acreages by the potential growth per acre to determine the productive capabilities of the region. Table 41 summarizes the softwood capabilities.

Table 41. Regional mean annual growth under intensive forest management

Forest Type	Potential Mean Annual Growth[1]			
	Good Site	Medium Site	Poor Site	Total
	(million cubic feet)			
White Pine	16	47	17	80
Red Pine	8	17	4	29
Jack Pine	28	76	31	135
Spruce-fir		175		175
Spruce	18	49	8	75
Tamarack		64		64
Cedar		57		57
All Softwood	70	485	60	615

[1]Mean annual growth for the region was computed by multiplying the acreages in each site and forest type by the mean annual growth for that site and type that was estimated to be attainable under fairly intensive forest management.

Yield Information--Hardwoods

Aspen

Aspen, which covers the largest forest acreage of the Lake States region and provides the greatest segment of the annual receipts of the pulp and paper industry, is of major importance in any prediction of future area capabilities.

The species is represented on a wide variety of sites upon some of which it cannot be cultivated economically and which must eventually be converted into other types or other land uses. However, upon the sites to which it is adopted, it provides a very important component of the regional commercial forests.

Despite the fact that aspen is currently in long supply, and that it is generally considered to be a temporary type, it is of major importance in any consideration of future area capabilities for such relatively short periods as 15 and 40 years.

Data obtained from measurements of well-stocked stands of aspen at age 40 years indicate the following yields can be expected under fairly intensive forest management:

Site	Yield (cords)	Average Height (feet)	Mean Annual Increment (cords)
Good	42	62	1.05
Medium	30	53	0.75
Poor	17	44	0.42

Source: U.S.D.A., Forest Service (Lake States Forest Experiment Station, Aspen Report No. 21).

Northern Hardwoods

The northern-hardwoods type, which ranks second only to aspen in acreage within the Lake States region has, until recently, provided a relatively small amount of pulpwood, and that chiefly from the hemlock component of the type. Hemlock has not been reproducing as the type has been harvested, and it has continued to furnish a smaller portion of the wood receipts of the region, until now its contribution has fallen below 100 thousand cords.

The hardwood component of the type, however, has always been an important source of material for the lumber industry, and in recent years second-growth material has begun to appear at the pulp mills. Much of the area in the type is unevenaged, and as a result the use of yield tables to predict capability is of no value. However, studies on small areas of northern hardwoods in upper Michigan indicate that, for average sites containing about 3,000 cubic feet of volume in a good distribution of size classes, a mean annual growth of 60 cubic feet, or 3/4 cord, could be maintained easily.[1] In addition, an average of ½ cord of topwood for each thousand board feet of sawlogs cut has been estimated to be obtainable on managed stands.

Oak

The oak type, which is prevalent in the southern half of the Lake States region, covers an appreciable area. It ranks third in acreage. A great portion of the area occurs, however, on farm and "other private" holdings, and as a result is made up of tracts which are difficult to handle economically due to their generally small size.

Studies made on fully-stocked oak stands in southern Wisconsin indicate that the following yields and growth can be attained under fairly intensive forest practice using a 60-year rotation:

F. H. Eyre and W. M. Zillgett, Partial Cuttings in Northern Hardwoods of the Lake States (U.S.D.A., Technical Bulletin No. 1076, 1953), p. 47.

Site	Yield (cu.feet)	Average Diameter (inches)	Average Height (feet)	Mean Annual Increment (cu.ft.)
Good	3,050	10.9	68	51
Medium	2,550	9.6	62	42
Poor	1,950	8.4	56	32

Source: U.S.D.A., Forest Service (State of Wisconsin Conservation Commission Publication No. 521).

Probably at least half of this growth would be necessary to sustain the lumber, veneer, and other wood-using industries, but if the pulp and paper industry were able to utilize the other half, particularly in the smaller size classes, it would be a great boon to the practice of intensive forest management upon the small private holdings of the southern half of the region.

All Other Hardwood Types

This category encompasses many of the lowland hardwoods, with elms, ashes, and soft maples predominating, and also the mixed hardwoods which occur in transitional zones between the northern hardwoods and the oak types. It is believed that for the average sites, a mean annual increment of 50 cubic feet could be maintained quite easily over a 60-year rotation.

Table 42 summarizes the annual capabilities, by growth, of the various areas in the region now devoted to hardwood production. A fairly intensive form of forest management is envisioned; intensive enough, that is, to secure a high density of stocking of the more desirable species.

Table 42. Regional mean annual growth under intensive forest management

Forest Type	Potential Mean Annual Growth[1]			Regional Total
	Good Site	Medium Site	Poor Site	
	(million cubic feet)			
Aspen	255	636	208	1,099
Northern Hardwoods		566		566
Oak	36	73	48	157
Other Hardwoods	—	151	—	151
Total Hardwoods	291	1,426	256	1,973

[1]Mean annual growth for the region was computed by multiplying acreages in each site and forest type by the mean annual growth for that site and type that was estimated to be attainable under fairly intensive forest management.

An examination of Tables 41 and 42 indicates the size and composition of the increased usable timber volume in the Lake States region, if reasonably intensive forest practices were to be introduced. The predicted volumes show an increase in the softwood component of growth from the present 319 million to 615 million cubic feet, and within the hardwood segment, a gain from 861 million to 1973 million cubic feet. The overall accretion of 1466 million cubic feet would be a gain of 125%.

The assumptions made in the computation of potential forest growth were far from extreme, and the results depicted are not fanciful. The predicted growth indicates a large portion to be in the hardwood component of the growing stock (75%), and this is partly due to the fact that the present distribution of forest types was assumed to carry on into the future. However, if determined forestry efforts are made in

type-conversion, there is every reason to believe that a greater portion of the increase could be channeled into the softwood segment.

Tables 6 and 7 in the Appendix give the breakdown of the regional growth figures by forest types and states. It is of interest to note how evenly the growth potential is proportioned between the three states, and also the fact that Minnesota has the greatest softwood and Michigan the greatest hardwood capabilities.

Recognizing that Wisconsin uses over 40% of the sawtimber and 55% of the pulpwood consumed in the region at this time, it becomes evident that from a wood procurement standpoint, the most advantageous areas for expansion of the timber industries would be in the states of Minnesota and Michigan. Minnesota would be better able to sustain those industries whose processes demanded the use of softwoods, while Michigan conditions are better suited for hardwood-dependent firms.

Of the estimated 550 million cubic feet of wood now used within the tri-state area, Wisconsin plants utilize 252 million or 46%. However, even this state, with its heavy concentration of timber supported plants, is currently growing more wood than it consumes, and could, on the basis of capabilities expand its production three-fold in the long-run.

Allowable Cut

The term "allowable cut" has come into frequent use since the U. S. Forest Service completed its latest survey of the nation's timber resources. Estimates of the allowable cut have been made for most of the states and regions where forests make up an important segment of the land resource, and great stress has been placed upon them.

Attention should be directed, at this time, to a consideration of the concept of allowable cut and to an analysis of its basis and to the method by which it is computed. As applied by the U. S. Forest Service in its inventory of the forest situation, allowable cut was defined as:

> the volume of merchantable live sawtimber and poletimber that can be cut during a given period while building up or maintaining sufficient growing stock to meet specific growth goals.[1]

The 1952 forest survey for Minnesota calculated that the current annual allowable cut should not exceed two-thirds of the current annual growth, if the specific growth goal was to obtain larger and more valuable yields in the future. In the surveys of both Minnesota and Michigan in 1953, the estimate of the annual allowable cut was approximately 64% of the current net annual growth, and the actual annual cut was only about 60% of the allowable annual cut.

The concept of allowable cut stems from the basic premise of volume regulation; that the annual cut should be fixed at a volume equal to the mean annual increment plus a portion of the surplus or minus a portion of the deficit existing between the actual growing stock and the growing stock desired for the forest or region.[2] If the volume of the desired growing stock is set too high, the allowable cut will be low, because the deficit must be made up from current growth. Conversely, if the volume of the desired growing stock is set too low, the allowable cut may be too high to accomplish the aim of securing larger and more valuable yields in the future. Therefore, in any estimate of allowable

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[1]U. S. Forest Service, Timber Resource Review (Chapter IX), p. 1.

[2]Herman H. Chapman, Forest Management (Bristol, Connecticut, The Hildreth Press, 1950).

cut, the fixing of the size of the growing stock needed to meet specific growth goals becomes an important decision.

It is conceivable that the size of the desired growing stock might be set at such a high figure, in an effort to build it up in a short period, that the annual cut would be greatly curtailed; this would lead to a rise in costs and, in turn, to the eventual substitution of wood by other materials. At the time the forest reached full productivity, markets for its products might not be available. This situation is not apt to arise in the Lake States region, for in all three states, although the allowable cut is fixed at only 60% of the net annual growth, the present drain (1953) is considerably less than that figure. However, it is always well to scrutinize allowable cut estimates with the aim of determining the basis upon which the size of the desired growing stock was fixed.

For the Lake States region, at present, the need appears to be for an increase rather than a curtailment in the use of wood products. The regional share of the national wood-products market can be lost unless a concerted effort is made to increase the use of local timber at least to the point of estimated allowable cut.

There are many measures, other than the curtailment of the annual cut, which can lead to the assurance of an adequate supply of the raw materials for the regional forest industries in the future.

Measures Needed to Assure Adequate Supply in the Future

In order to make progress toward sustaining the regional forest industries in the future, and to take care of the predicted expansion in the future use of the products of these industries, many measures need to be adopted. At this time the adoption of some of them is not economically feasible, but all should be considered for employment at a later date.

There is a definite challenge to the foresters of today to produce greater overall benefits from the forests, and a pressing need to produce more wood per acre at a reasonable cost. Foresters cannot wait for future demands before making plans to grow more wood. They must anticipate those demands and prepare to meet them now. Today's production decisions and actions will affect future consumption, for future consumption will depend to a large extent on the price existing at that time, and the price will be strongly influenced by the supply prevailing then.

S. S. Patterson in his discussion of the potential productivity of the world's forests clearly defined "intensive forestry" when he said:

> Intensive forestry requires heavy investment both in labor and materials, and an adequate supply of professional skills. The cost of additional inputs has to be balanced against the market value of the supplementary yields they will generate . . . . Forest area alone is an inadequate measure of forest wealth. It is the climatic and site factors governing growth, and the intensity of management that determine what volume of wood an area can furnish.[1]

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[1] S. S. Patterson, Forest Area of the World and its Potential Productivity (University of Goteborg, 1956).

The direct contributions which intensive forestry can make to the assurance of a future supply of wood within the region fall within three general categories.

First, are those concerned with the securing of reproduction on forest lands, in sufficient quantities and of the desired species. More and more, foresters are considering the use of artificial methods of reforestation when dealing with short-rotation crops and highly productive sites. Tremendous progress has been made in the techniques of both planting and direct seeding, and the use of mechanical equipment in each operation has constantly lowered the costs.

The reforestation job within the region is a large one. Rudolph, in 1946, estimated it at 12½ million acres, and visualized the job as necessitating the planting of 250 thousand acres annually over a 50-year period, and demanding an annual nursery capacity of 200 million plantable trees.[1] A program of such magnitude is difficult to visualize. However, it might be possible, with the use of herbicides for site preparation and direct seeding by aircraft, to accomplish the job on larger tracts in a much shorter time. The major advantage of direct seeding is that a large program need not be delayed for lack of planting stock or manpower. Forestry research would have to make it feasible by developing methods which could be executed at a reasonable cost. No possible avenue of approach should be neglected in dealing with the reforestation problem.

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[1]Paul O. Rudolph, The Reforestation Job in the Lake States - A New Estimate (U. S. Department of Agriculture, Forest Service, Lake States Forest Experiment Station Paper No. 4, 1946), p. 9.

The second category deals with the forestry cultural operations which must be put into practice in order to secure optimum stocking of the desirable species in stands which are presently established, or upon those which are to be regenerated by natural means. The measures necessary to accomplish this objective include (1) the installation of better cutting practices, and (2) the application of more intensive forest-improvement procedures. These measures should be taken first on those lands which are most accessible and are composed of the potentially highest productive sites. The installation of intensive cultural improvements demands an investment, and it will seldom seem economically possible to make it, unless there is a market for the small-size, low-grade trees which are a product of the cuttings.

Investments in the following operations must be made if the future production goals are to be achieved, and constant research must be conducted to determine methods whereby the job can be done most efficiently:

1. Site preparation - for the securing of natural reproduction and control of unwanted species. The use of prescribed fire should be considered in conjunction with mechanical methods.

2. Brush control - to be used in site preparation, and in weedings and precommercial thinnings. The use of new herbicides applied by aircraft has made this operation feasible on many areas. John Arend of the Lake States Forest Experiment Station has estimated that, within the region, there are over 1½ million acres of pine plantations alone which need release, and that in addition there are many more thousands of acres of satisfactorily stocked, but overtopped natural coniferous stands in need of treatment. On large areas, he estimates the cost of aerial

application to be less than $5.00 per acre.[1]

3. Early and frequent thinnings - to prevent stagnation and to salvage natural mortality, as well as to increase the growth on the remaining trees. Mechanical methods which decrease the costs of forestry and logging should be considered under this operation.

4. Control and removal of cull trees - to eliminate low quality or worthless material and thereby assure that the site will produce at approximately its maximum capacity. On some areas much of this material can be removed at a profit, or at least some return can be obtained from it. Where it is impossible to market the material, efforts should be made to have it removed as cheaply as possible at the time of harvest, when money is available for investment. It is in the incurring of such costs as these, that all forest owners need special encouragement.

5. Decrease the non-commodity drain or loss - losses due to fire within the region are now well within the limits necessary for the practice of intensive forestry. Presently less than .3% of the commercial forest area of the region is burned annually, and for the period 1948 to 1953 only .4% was lost each year. Protection is afforded to all the commercial forest land within the region.

However, losses due to disease,insects, and miscellaneous causes such as animals and wind remain very high. In 1952, they were estimated.

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[1]John A. Arend and L. L. Coulter, "Aerial Applications of Herbicides," Down to Earth (The Dow Chemical Company, Summer, 1955).

to have caused the loss of nearly 2 billion cubic feet of growing stock.[1] To many people, the decreasing of this loss is a public function to be handled by federal or state agencies, but much of the loss could be eliminated by the fairly simple expedient of intensive silvicultural practices by the landowners themselves, where they are economically feasible. It must be realized that the practices of intensive forestry cannot be carried on unless the danger from the losses cited can be reduced to a percentage equivalent to normal business risk. Conversely, however, it is in many cases primarily through intensive management practices that the losses are reduced.

The third category deals with those measures over which the industry itself, through its research or by means of modification of its manufacturing or production methods, has a great amount of control. The pulp and paper industry should be encouraged in every possible way to explore and where practical exploit the advantages to be derived from improved utilization practices and from the development of new and more efficient means of harvesting and processing wood.

Impressive progress has already been made by the industry in these fields, but much more remains to be accomplished. The breakthrough into the use of hardwoods and other relatively little-used species in woodpulp has gone a long way towards providing the pulp and paper manufacturers with a reasonably cheap source of wood much closer to their mills. It has served two additional purposes: (1) that of prolonging the supply of the species in heavy demand, and (2) that of holding the softwood prices

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[1] U. S. Forest Service, Timber Resource Review (Chapter IVA), p. 10.

in check. The limiting factor here will be the continued expansion in the demand for papers of the type which can be manufactured from these species.

The emphasis given to the use of wood-residues by the industry has been effective in prolonging the supply of the available roundwood. The use of this material is expected to increase greatly, but its expansion will be limited by the market for lumber and by the size of the average saw mill in the region. If full advantage is to be taken of this measure to assure future supply, there must be close cooperation between segments of the pulp and paper and the lumber industries, and every effort must be made to increase the efficiency of the entire operation from sawmill to pulpmill. It is not too early to set in motion and keep operative a sizeable chip program within the region. R. M. True of S. D. Warren Company in discussing his company's policy of using chips in New England stated:

> We did not need this program at present, but went into it because of our belief in forest conservation, and our anticipated future expansion and consequent pulpwood requirements.[1]

John Raeburn of Coosa River Newsprint Company expressed the belief of many of the woodlands Managers who were questioned concerning the future of chips when he said:

> It is thought that all sawmills will eventually have chipping and debarking operations. The mills use of these chips will increase until the sawmills have either installed this equipment or gone out of business.[2]

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[1]R. M. True, "Purchasing and Handling Chips in New England," Minutes of the Lake States Technical Committee (May, 1959).

[2]John Raeburn, "Leaders of Industry Look to the Future," Pulpwood Production, Vol. VIII, No. 7 (July, 1960), p. 28.

Too little emphasis by industry has been placed upon the problems of the inaccessibility of forest areas and the increasing costs of pulpwood procurement. Greater stress must be placed upon cheaper methods of collecting, producing, and marketing pulpwood. Mechanization of all operations must be encouraged if wood is to be supplied at a price which will not curtail the demand for the ultimate paper products. It can only be promoted if (1) the forests are made accessible by an all-weather highway system, and (2) larger volumes of timber are made available so that the producers can be assured of a steady year-round supply in amounts large enough to warrant the investment in equipment. Tom Powell recognized this problem and pointed up the need to establish a permanent production force for the securing of the pulpwood supply. However, he recognized that reliance for the timber supply in the Lake States region must be placed to a large extent upon woodlots and public forests. Public sales are often infrequent, include timber which is not desired, and are in inaccessible areas where there are no cutters. Woodlot sales are also sporadic in occurrence, and are usually of such small size that mechanization of the operation is impractical.[1]

In addition to the direct measures discussed above, which industry can take to assure its future supply of pulpwood, there are numerous indirect steps, principally in the realm of policy, which may have to be taken.

Since land purchase by industry within the region would be very difficult at this time, it is necessary that the present ownership

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[1]Tom R. Powell, "Lake States to Benefit by Steady Production, Better Use of Public Timber," Pulp and Paper (July, 1958).

pattern be examined and policies formulated to govern future action. In the province of public lands, industry could gain immeasurably by advocating their consolidation, and by supporting legislation designed to make them more accessible. With 40% of the area's commercial forest land in public ownership, the industry should be concerned about the policies being pursued relative to timber sales, withdrawals from commercial use, and silvicultural operations on them.

For the residual 60% of the area still remaining in private hands, three alternatives appear to be possible as measures designed to insure the future supply. The first of these deals with the use of long-term land leases or timber options, a measure which has met with success in some other sections of the United States. To be successful, the use of this system generally requires that the lands to be leased be in fairly large ownerships, and this situation occurs rarely within the Lake States private-land-ownership classification. However, where it does occur, this method could be tried by the industry as a means of assuring future wood supply without having to assume the burden of land ownership.

The second alternative is based upon the use of land-owner agreements and cooperative management plans. This system too has been successfully utilized in other regions. It is quite well suited for use with the medium and smaller-size ownerships. The aim here is to assure future supply by providing the landowners with such services as professional forestry assistance and credit. The goal, in this instance, is to intensify forest practices on the private lands, so that the output will be both greater and steadier in the future. To indicate what is

being done within the region in this category, an excerpt from Harold Titus's article in Field and Stream is quoted:

> Eight of the larger hunting clubs in the Lower Peninsula of Michigan (Over 100,000 acres) are under contract for pulpwood cutting on their aspen lands. This action was brought about primarily by a policy fight and publicity.[1]

If each individual management plan becomes a part of an overall plan for the mill's working circle, the volume of the output may be controlled and assured.

The third alternative deals with that segment of the private-land ownership controlled by farmers. In the Lake States region, this group of owners controls nearly 30% of the commercial forest land and provides an even greater share of the annual needs of the area's wood-using industries. In 1954, the U. S. Census reported that 9,744 farms within the tri-state area accounted for the production of 324 thousand cords of pulpwood. This was 14% of the wood produced locally for the industry that year. The average cut was 33 cords per reporting farm. Zon and Duerr estimated in 1942 that over 50% of the timber cut annually in the Lake States, and over 25% of all the raw materials used by the forest industries of the region came from lands under this form of ownership.[2] This record was made despite the fact that the size of the average woodlot was only 25 acres and the class of forestry practices on it was the lowest recorded for any private ownership. The facts that the farm holdings in general are readily accessible and are of relatively good

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[1]Harold Titus, "A New Business Deal for Deer," Field and Stream, Vol, LXI, No. 8 (Dec., 1956), p. 50.

[2]Raphael Zon and William A. Duerr, Farm Forestry in the Lake States: An Economic Problem (U.S.D.A., Circular, No. 661, November, 1942), p. 33.

timber-growing quality seem to have no bearing on the level of forest management practiced on them.

To emphasize that this situation is not unique in the Lake States or even in the United States, the observations W. K. Williams made in Germany, where intensive forestry has been practiced for generations, are presented:

> The situation in regard to farm forests has been studied and is a matter of real concern. It is reported that the annual growth on farm woodlands is about 1/3 that on State lands or on large private holdings. One German forester said that the error in the past was issuing forest policy regulations instead of teaching forest management practices. . . He thinks that farmers will not be convinced by words alone or by regulations, but in addition need good forestry demonstrations.[1]

John A. Zivnuska, reporting on private forestry in Norway stated:

> It appears to be the general opinion of Norwegian foresters that the present level of small woodland management is definitely unsatisfactory. Norwegian foresters are convinced that, despite the fact that a forest cover is maintained on most farm forests, over longer periods of time present operations result in stand deterioration and low yields.[2]

Possibly the 30% of forest land in this ownership could be made to produce at an increased rate by adequate help and demonstration. If it could, it would make available to the industry a readily accessible source of wood.

It appears that the rising cost of wood and the tremendous increase in wood-dependent investments will make it good industrial policy to promote intensive timber growing practices on all forest lands within the

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[1]W. K. Williams, "Observations of European Forestry," Random Forestry Notes for Extension Foresters (November, 1949).

[2]John A. Zivnuska, "Private Forestry in Norway," Forest Science Monograph I, Society of American Foresters (1959).

region regardless of ownership, and particularly upon those lands within each firm's timbershed. Such a program should receive enthusiastic public support, for the Forest Service recently estimated that for every eighty acres of well-managed and well-stocked timberland one man would be afforded full-time employment, when both woods and mill operations were considered. It is evident that the luxury of non-stocked or poorly stocked forest land can no longer be afforded in the United States or any of its forest regions.

X. SUMMARY

"What lies ahead for the Lake States pulp and paper industry?" The answer to this question should be of the utmost concern to the residents of the region because of the widespread influence of the industry on the Lake States' economy. It should be evident that any appreciable slackening in the growth pattern of the industry, and any failure on its part to at least maintain and preferably expand its position nationally, may have serious repercussions on the social and economic welfare of the area.

What of the outlook for the future? The regional growth of the pulp and paper industry, as has been true in the past, appears to be geared first to the demand for its products, and then to the continuing availability of an adequate supply of raw materials, labor, and capital. Competition from other producing areas will also affect the growth, and it appears that the region must exploit all of its advantages to the utmost in order to hold or extend its position. It appears that producing capacity will tend to expand in those regions where wood costs and other expenses of production and distribution remain sufficiently low to permit an adequate return on the investment.

Assuming even median projections for the consumption of pulp, paper, and board products in the future, it is probable that the increase in their use will be substantial, even though the annual gain may be at a rate slower than that made from World War II to the present. Consequently, the industry can probably look forward to an increase in consumption, but

at a decreasing rate. However, innovations and technological advances within the industry may change this picture.

From where will the enlarged production to meet the projected increase in demand come? Future increases in production will probably be governed by the same factors that controlled expansion in the past. It can be anticipated that the availability of an adequate supply of pulpwood which can be placed on the mill yard at a reasonable price, assisted by an ample supply of water and labor, will continue to aid this region in securing its share of the national growth.

Despite the relatively favorable outlook for the region in the near future, there are some economic considerations that may have an adverse influence upon future pulpwood production in the area. In the first place, there will be a vast amount of competition for the use of the available forest acreage from other land users. In addition, there will probably be tremendous pressure exerted by other land-using groups, such as the recreationists, game and fish enthusiasts, and water-resource people, to modify the timber-growing practices on forest lands in order to make them more compatible with their uses. This modification may in turn prevent the reaching of maximization of timber production.

The extraction of lands from areas now devoted to timber production, and their allotment to a reserve status can also have a decided effect upon the pulpwood producing capabilities of the region. So, too, can the competition provided by other wood-using industries for the available supply of raw materials. This latter factor does not appear, at present, to pose the threat to the future pulpwood supply that is directed toward it by "other land uses," for the past trend in the production of other

wood products within the region has generally been downward.

It is possible to visualize in the future, in conjunction with a rising personal income within the region, that fewer relatively unskilled workers may be available for the harvest of the pulpwood so necessary for sustaining the industry. A shortage of this type of labor could be responsible for a large increase in the procurement cost of pulpwood and place the region in a weak competitive position by means of a cost-price squeeze. Evidence, however, points to the fact that the industry, nation-wide, is cognizant of this possibility and is making strides in the mechanization of the woods operations in an effort to forestall such a possibility.

Because paper products compete in the market with many other materials, the future consumption of these items will depend, to a large extent, on the prices and qualities they exhibit in relation to those of competing products. Then too, that portion of the overall consumption garnered by the Lake States region will depend upon these factors and also upon their relationship to competing regions producing the same product.

Because wood as a raw material plays such an important part in determining the price of pulp products, specific emphasis must be placed upon the forests and timber-stand improvement in order to sustain the wood-using industries domiciled in the region, and to stimulate and encourage additional industrial development utilizing forest resources.

The region is in a fortunate position relative to pulpwood prices. The rates of increase in the prices of the principal regional species (f.o.b. cars) have been slower than those of woods in some competing

regions. In addition, on the basis of deflated prices, the cost of aspen has actually decreased in recent years. However, the cost of logging appears to extract too great a share of the delivered price of wood in the Lake States region. The substitution of capital for labor in the form of mechanization, and the operation of larger sales could accomplish a great deal to remedy this situation. It is within the logging phase of pulpwood procurement that the greatest cost reductions seem possible. The installation of intensive forest management upon lands close to the mills can lead to a decrease in the average cost of logging, and also to a lower average cost of transportation to the plants.

The improvement of timber resources within the region will provide additional raw materials for expanding industry. This, in turn, will mean new and enlarged industrial payrolls, greater employment opportunities and improved income for retail, wholesale, and service industries in the area.

Realizing that population is expected to increase over 60%, and personal income to double in the next 40 years, it should be evident that the increased wood needs engendered by these events can only be met by intensification of forest management on the lands devoted to timber production.

It is believed that the forests of the Lake States are in a good position to assume their share of the future expansion in the pulp and paper industry, and if efforts and energy are concentrated at once upon needed forestry research and forest policies, this region can not only continue to hold its share of the market, but also increase it.

There is a feeling of trepidation on the part of some forest industries within the Lake States that their future wood needs may not be met locally, due to the large proportion of commercial forest land in public ownership within the region. Past records indicate, however, that the annual cut from federal forests continues to increase, and that the volume of wood removed from state and county forests is just now reaching the stage where large increases will be possible in the next decade. Unless radical changes occur in public forest policies, it appears that public lands will be able to provide a constantly increasing share of the needs of the industry under a sustained yield operation.

One item above all others can prevent this region, or for that matter any other region, from expanding, if an adequate wood supply is available, and that is complacency on the part of both industry and landowners. R. V. Miles, Jr., of Gulf States Paper Company, warned of this when he spoke to a group of southern foresters and said:

> We can exceed our most optimistic expectations, if we do not accept our present situation with complacency, because first our forest production can actually be doubled in a matter of relatively few years if we apply to our timberlands the sound economic principles of sustained maximum-yield multiple-use forestry. Secondly, our manufacture and sales can also be doubled if we continue to create new and useful quality products from wood.[1]

Even though this statement was addressed to foresters in the South, the sentiments apply equally well to all regions and to all segments of the industry built upon wood use.

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[1]R. Vance Miles, Jr., "Opportunities in our Southern Forests," (Keynote address, Alabama Chapter, Society of American Foresters, August, 1960).

It appears that the present estimated growth of 1.18 billion cubic feet of wood is more than twice that needed to support the current forest industries of the region. There is an annual surplus of over 600 million cubic feet of growth over drain, and this would allow the expansion of the pulp and paper industry to the extent of an additional 50 mills in the 300-ton class. However, the current net annual growth within the region is composed of 73% hardwoods and 27% softwoods, while the current utilization within the pulp and paper industry is on the basis of 52% softwoods and 48% hardwoods. Despite the excess of growth over drain in both the softwood and hardwood components now, it is obvious that future expansion must be in the form of plants capable of using the hardwoods, if sustained operation on local wood is the goal.

If fairly intensive forest management were to be practiced upon the woodlands of the region, the surplus would become 2 billion cubic feet, a volume easily capable of sustaining the predicted consumption of 1.35 billion cubic feet in the year 2000. This would allow the Lake States to expand and reclaim some of the ground lost to other regions in the past three decades.

It is important that expansion should take place in those sections of the region where the greatest surpluses occur, and consist of the type plants capable of using the species which make up the excess. These two stipulations just about eliminate Wisconsin from the expansion plans at present, and focus the spotlight on the Northern Lower Peninsula and Eastern Upper Peninsula of Michigan, and the eastern and central sections of Minnesota. Most of the expansion will have to be in the form of plants capable of using hardwoods, but some increase could be supported

for mills utilizing pine.

Every indication points to a vigorous growth of the pulp and paper industry within the region if it can continue to get its pulpwood at a reasonable cost. Some old mills will have to drop out, but the newer mills should enjoy increasing productivity due largely to economies of scale and efficiency of modern plant design.

Assuming a median growth rate of 3%, the regional output of paper and paperboard products should expand to 7.7 million tons by 1975 and should reach 16 million tons by 2000. If this projected output is to be maintained by a domestic supply of wood pulp, it will necessitate a regional pulp-producing capacity of 5.55 million tons by 1975 and 11.6 million tons by 2000. To support this capacity with local wood, it will be necessary for the forests of the region to provide 500 million cubic feet of pulpwood by 1975 and 1 billion cubic feet by 2000. An additional 325 million cubic feet must be provided in 1975 and 350 million in 2000 to support the other regional wood-using industries. The region is currently producing, by growth, a cubic volume of wood greater than that estimated to be needed in 1975, and by the institution of fairly intensive forestry practices could grow twice the volume necessary in 2000.

The size of the regional growth will depend to a large extent on the cooperation existing between foresters and industry, whereby efficiency of land management will provide the firms with a sustained reasonably-priced supply of wood, and efficiency of plant management will make available to the forester a constant market for his products at a price which will cover his expenses and contribute interest on the investment.

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APPENDIX

Table 1. Predictions and actual values of various economic indicators

Indicators and Years	Units	Agencies: Stanford Report 1953	Timber Resource Review 1954	U.S.D.C. B.D.S.A. 1959	R.F.F. (median) 1957	American Marietta Company 1959	Actual
U.S. Population	million						
1960		176	176	Same	180	180.1	*178
1965		187	187	as	192	195.7	
1970		199	199	R.F.F.	205	213.8	
1975		212	210		235	235.2	
1980					240		
2000			275		310		
G.N.P.	$billion						
1960		412[1]		465	520	500	*485
1965		465		540	620	610	
1970		527		700	750	750	
1975		586		830	900	925	
1980				980	1075		
2000				1900	2200		
Consumption Paper Paperboard	million tons						
1960		37.4		40.8	240.0	35.1	*39.0
1965		42.7		48.6		43.3	
1970		47.9				52.2	
1975		53.5				64.2	
2000				155.0	240.0		
Index of Industrial Production	1947-49-100						
1960		151		163		170	*153
1965		172		192		210	
1970		198				270	
1975		222				340	
1980				370	482		
2000				773	1190		

*Preliminary estimate

[1]Graphic interpolation

Table 2. Wholesale price indexes for lumber, paperboard, and selected construction materials, 1930-1959
(1947-49 = 100)

Year	Lumber	Struct. Steel	Paper Board	Struct. Clay	Constr. Material	All Commodity	Plywood
1930	28.5	54.8	37.3	58.8	46.8	56.1	
1931	23.1	52.2	31.6	54.8	41.2	47.4	
1932	29.4	50.6	31.4	50.6	37.2	42.1	
1933	29.5	52.2	41.2	51.9	40.1	42.8	
1934	28.1	57.0	47.4	59.1	44.9	48.7	
1935	27.2	57.8	41.4	58.6	44.4	52.0	
1936	28.9	59.7	41.5	58.1	45.1	52.5	
1937	33.1	71.1	48.9	61.2	49.6	56.1	
1938	29.0	69.7	41.4	59.6	47.0	51.1	
1939	31.0	67.4	42.5	59.9	47.1	50.1	
1940	34.2	67.4	48.6	59.3	49.4	51.1	
1941	40.7	67.4	54.7	61.4	53.7	56.8	
1942	44.2	67.4	56.3	64.2	57.4	64.2	
1943	47.0	67.4	60.6	64.9	58.0	67.0	
1944	50.9	67.4	62.0	66.6	60.1	67.6	
1945	51.5	67.4	64.6	73.6	61.3	68.8	
1946	59.3	74.4	71.2	80.5	69.1	78.7	
1947	94.5	84.5	99.2	91.7	94.0	96.4	95.9
1948	107.3	102.8	102.0	102.4	104.4	104.4	109.0
1949	98.2	112.6	98.8	105.9	102.0	99.2	95.2
1950	114.5	121.0	105.0	110.2	109.5	103.1	106.5
1951	123.6	128.4	131.8	117.8	119.6	114.8	115.1
1952	120.5	131.1	127.4	122.0	118.2	111.6	105.0
1953	119.3	138.2	124.3	128.1	119.9	110.1	109.3
1954	117.3	143.8	124.5	133.1	120.2	110.3	103.1
1955	124.4	151.9	127.1	140.1	125.5	110.7	105.4
1956	127.2	162.9	134.8	148.0	130.6	114.3	101.7
1957	119.7	187.5	136.3	154.0	130.6	117.6	96.4
1958	118.0	196.0	136.2	156.5	130.5	119.2	97.1
1959*	126.0	199.6	136.2	160.0	134.5	119.7	104.0

* Preliminary estimate.

Source: U. S. Department of Labor, Bureau of Labor Statistics.

Table 3. United States consumption and imports of pulpwood--1940-1959

Year	Consumption	Imports	Imports as % of Consumption
1940	13,742,958	1,435,820	10.5
1941	16,580,000	1,632,605	9.8
1942	17,275,000	1,733,431	10.0
1943	15,644,500	1,391,392	8.9
1944	16,757,400	1,368,109	8.2
1945	16,911,861	1,562,877	9.2
1946	17,817,560	1,728,253	9.7
1947	19,714,229	1,829,540	9.3
1948	21,189,458	2,020,979	9.5
1949	19,945,440	1,418,567	7.1
1950	23,627,217	1,412,365	6.0
1951	26,521,795	2,510,223	9.5
1952	26,460,730	2,124,880	8.0
1953	28,140,922	1,552,340	5.5
1954	29,679,363	1,602,978	5.4
1955	33,356,476	1,764,847	5.3
1956	35,748,582	1,869,652	5.2
1957	35,745,543	1,766,804	4.9
1958	35,248,367	1,361,263	3.9
1959	38,690,519	1,277,674	3.3

Source: United States Bureau of the Census

Table 4. Wood pulp imports of the United States by grades, 1940-1959

Year	Grades (tons)				Total All Grades
	Chemical	Mechanical	Screenings: Chemical	Screenings: Mechanical	
1940	1,045,534	170,909	7,523	604	1,224,570
1941	944,403	197,991	9,055	6,437	1,157,886
1942	1,002,587	219,876	7,549	6,507	1,236,519
1943	1,052,383	236,484	10,751	5,931	1,305,549
1944	882,710	176,887	7,241	5,026	1,071,864
1945	1,519,338	222,710	7,309	4,708	1,754,065
1946	1,540,759	250,222	8,632	5,875	1,805,488
1947	1,999,259	308,946	9,552	4,703	2,322,460
1948	1,872,299	290,984	8,275	4,553	2,176,111
1949	1,545,194	208,817	3,163	5,928	1,763,102
1950	2,095,116	279,611	4,695	5,759	2,385,181
1951	2,027,176	318,093	10,344	5,093	2,360,706
1952	1,690,535	242,240	4,260	4,224	1,941,259
1953	1,887,233	259,358	6,688	4,295	2,157,574
1954	1,801,857	238,921	7,076	3,944	2,051,798
1955	1,950,164	251,145	8,705	3,339	2,213,353
1956	2,048,380	270,916	12,689	2,268	2,334,253
1957	1,862,070	229,707	13,550	1,354	2,106,681
1958	1,891,233	199,110	10,748	698	2,101,787
1959	2,192,842	228,583	9,119	889	2,431,433

Source: United States Department of Commerce

Table 5. Site classification, area of commercial forest land in the Lake States--1945

Forest Type	Good Site				Medium Site				Poor Site			
	Region	Mich.	Minn.	Wis.	Region	Mich.	Minn.	Wis.	Region	Mich.	Minn.	Wis.
	Thousand acres											
White Pine	103	34	30	39	392	127	110	155	193	69	60	64
Red Pine	102	29	45	28	302	107	110	85	112	59	25	28
Jack Pine	474	109	250	115	1,608	488	740	380	1,007	488	250	269
Spruce-fir	522	222	180	120	2,035	895	665	475	937	375	365	197
Spruce	436	87	300	49	1,644	346	1,005	293	995	144	706	146
Tamarack	162	31	100	31	1,002	199	635	168	429	77	245	107
Cedar	320	196	80	44	992	470	360	162	317	118	110	89
N. Hardwoods	1,716	986	60	670	4,847	2,712	480	1,655	2,832	1,232	650	1,000
Oak	710	135	105	470	1,740	405	285	1,050	1,495	360	320	815
Ash-elm	560	245	95	220	1,612	539	465	608	811	196	370	275
Aspen	3,031	885	1,500	646	10,627	2,950	4,125	3,552	6,200	2,065	1,875	2,260
ALL TYPES	8,136	2,959	2,745	2,432	26,801	9,238	8,980	8,583	15,408	5,193		5,250

Source: U. S. Forest Service, Lake States Forest Experiment Station Paper No. 1

Table 6. Future annual growth for the Lake States under intensive forestry practices

Forest Types	Sites								
	Good			Medium			Poor		
	Mich.	Minn.	Wis.	Mich.	Minn.	Wis.	Mich.	Minn.	Wis.
	(million cubic feet)								
White Pine	5.1	4.5	5.9	15.4	13.3	18.7	6.2	5.4	5.8
Red Pine	2.4	3.7	2.3	6.0	6.2	4.8	2.3	1.0	1.1
Jack Pine	6.5	15.0	6.9	23.0	34.8	17.9	14.8	7.6	8.2
Spruce-fir				74.5	60.5	39.6			
Spruce	3.7	12.7	2.1	10.2	29.7	8.7	1.1	5.6	1.2
Tamarack-cedar				35.7	61.2	24.0			
SOFTWOODS	17.7	35.9	17.2	164.8	205.7	113.7	24.4	19.6	16.3
Aspen	74.5	126.0	54.3	177.0	247.0	212.0	69.3	63.0	76.0
N. hardwoods				296.0	71.5	199.0			
Oak	6.9	5.4	24.0	17.0	12.0	44.1	11.5	10.2	26.1
Other hardwoods				49.0	46.5	55.1			
HARDWOODS	81.4	131.4	78.3	539.0	377.0	510.2	80.8	73.2	102.1
TOTAL	99.1	167.3	95.5	703.8	582.7	623.9	105.2	92.8	118.4

Table 7. Summary of future annual growth capabilities of the Lake States under intensive forestry practices

Forest Types	States			Lake States Region
	Michigan	Minnesota	Wisconsin	
	(million cubic feet)			
White Pine	26.7	23.2	30.4	80.3
Red Pine	10.7	10.9	8.2	29.8
Jack Pine	44.3	57.4	33.0	134.7
Spruce-fir	74.5	60.5	39.6	174.6
Spruce	15.0	48.0	12.0	75.0
Tamarack-cedar	35.7	61.2	24.0	120.9
SOFTWOODS	206.9	261.2	147.2	615.3
Aspen	320.8	436.0	342.3	1,099.1
N. hardwoods	296.0	71.5	199.0	566.5
Oak	35.4	27.6	94.2	157.2
Other hardwoods	49.0	46.5	55.1	150.6
HARDWOODS	701.2	581.6	690.6	1,973.4
TOTAL	908.1	842.8	837.8	2,588.7