

A STUDY OF THE PAPER INDUSTRY  
IN THE  
NORTHEASTERN UNITED STATES

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OUTLINE OF THE PROBLEM  
REGIONAL PULPWOOD SURVEY  
THE NORTHEAST

I. The Position of the Regional Industry

A. History

1. Early Paper Industry
2. Establishment in N. E.
  - a. History of Lumbering
  - b. What was left for the paper industry

B. Competitive Position by Grades

1. Accessibility to markets
2. Ability to service markets and special classes of consumers
  - a. Age, general condition, size, and speed of equipment (statistical)
  - b. Portion of the market that can be served by other mills in other regions

C. Cost Factors - Comparisons

1. Raw Materials
2. Conversion Costs
  - a. Labor
  - b. Carrying Charges
    - 1a. Equipment
    - 2a. Woodlands
3. Break-even Charts
4. Pulpwood requirements, consumption, and production by grades
  - a. From within region
  - b. Other regions and foreign

II. Regional wood costs with present distribution of supplies

A. Regional resources

1. Forest land areas
  - a. Private ownership
  - b. Public ownership
2. Growing Stocks
  - a. Pulping species
  - b. Non-Pulping species
    - 1a. Potential pulping species
3. Growth rates and total growth
4. Drain
  - a. Pulpwood
  - b. Other uses
5. Balance of above and future outlook

B. Cost of producing pulpwood - present

1. Stumpage
  - a. Cost to mill by purchase, contract, or own timber
  - b. Comparison with costs for other uses
2. Cutting, peeling, piling, and landing costs
3. Transportation costs (including loading and unloading)
  - a. Truck
  - b. Rail
  - c. Barge
  - d. Driving
  - e. Combinations

4. Other costs
  - a. Margin to contractor
  - b. Protection costs
5. Future possibilities affecting wood costs
  - a. Possible reductions in cost through application of principles of management to mill owned land
  - b. Through applications of cost economy in the woods
  - c. Increased transportation costs with cutting of available timber

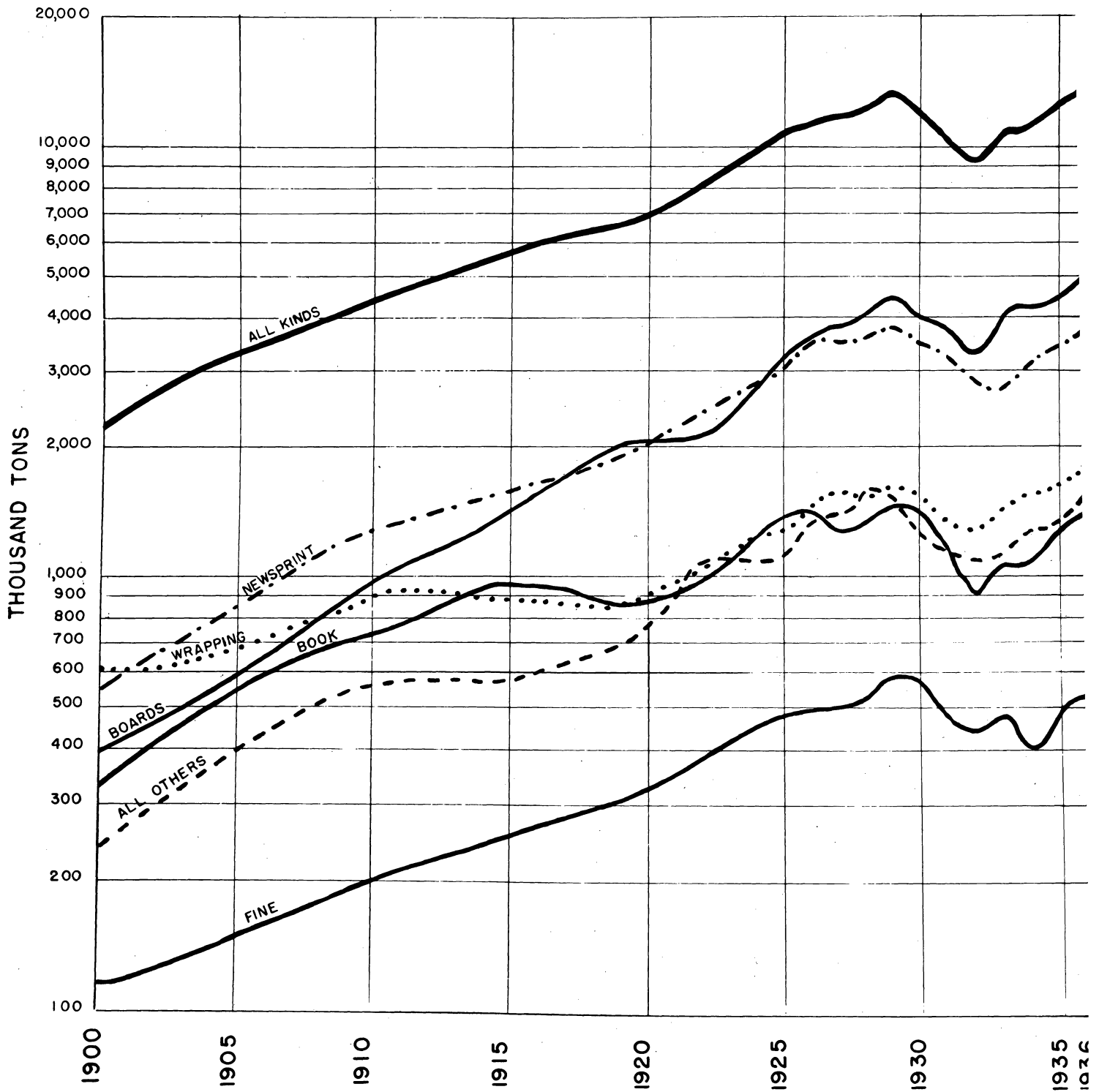
### III. Regional Wood Costs under forest management

- A. Plans to be considered in presenting costs and returns between:
  1. Intensive versus extensive forestry
  2. For pulpwood only or integration
  3. Even or all-aged
  4. Other silvicultural plans
    - a. Thinnings
    - b. Improvement cuttings
    - c. Planting
- B. Growth and Yields
  1. By sites, rotation, intensities, species
  2. Yields from thinnings
  3. Yields from other products
  4. Money rates of growth
- C. Costs under Forest Management
  1. Land costs or rent
  2. Discussion of adjustment in regional costs and land values from long-run point of view
  3. Interest as a cost
  4. Taxes
  5. Administration
  6. Protection
  7. Planting costs
  8. Silvicultural costs
- D. Stumpage costs under forest management
  1. By sites
    - a. Profit or loss
    - b. Possibility of offsetting higher stumpage costs through lowered transportation costs.
- E. Ratio of forest to mill investment

### IV. Summary - Discussion of:

- A. Reliance on outside sources versus owned land and wood
- B. Degree to which forestry is justified on a cost basis - present and future
- C. Forest lands under management as a stabilizing influence in the community.

# PAPER CONSUMPTION IN THE UNITED STATES BY KINDS 1900 - 1936



A REGIONAL STUDY OF THE PAPER INDUSTRY  
IN THE NORTHEASTERN UNITED STATES\*

Purpose of the Study

With the great economic and geographic shifts now taking place in the modern pulp and paper industry, it becomes increasingly difficult for the paper mill executive, the economist, and the forester to predict where the eventual state of equilibrium in regional paper production will rest. Today, as never before, the paper industry is in a state of transition -- not from the viewpoint of changes from old industrial methods to new, nor of major shifts in the types of basic raw materials, but rather in a severe competitive struggle between the various producing regions as well as between domestic and foreign pulp and paper producers. The struggle is one for markets -- the production of new regions meeting the production of old and established regions in common markets. Rather rapidly, the transition period which began in the early 1920's has seen a shift of newsprint production to Canada, of wrapping and bag paper production to the South, and the establishment of new sulphite units in the Pacific Northwest. As these new areas have progressively entered into the established markets of the older regions, the older industry has, in general, undergone major changes. New products have been developed, the consuming public has been introduced to new uses for paper, as well as to the advantages of substituting paper for other and costlier commodities, and the older regions have developed markets for these new products.

With the shift of production in the older regions to specialized and higher grade papers, it is an economic eventuality that new producing

\* New England and Middle Atlantic States.

regions will gradually, but surely attempt to shift part of their production to enter these markets. While many technical and business difficulties now stand in their way, it has been characteristic of the industry to surmount all difficulties in the course of time.

As these regional struggles occur, international political developments complicate the situation even farther. Changes in tariff schedules may upset an equilibrium which has taken many years to reach in the international pulp and paper trade (for pulp and paper is truly an international commodity). War in foreign nations and the new doctrines of economic self-sufficiency now rampant in many countries may curtail established pulp supplies and reflect directly upon the domestic competitive situation between the regions.

To a great extent the story goes back to pulpwood costs and present and eventual regional superiority may rest upon forest land values and costs of delivered wood. But by no means does the wood problem strike at the heart of the situation. Regional wood costs may be extremely low and result in low production and delivered costs of pulp and paper; but to produce cheaply is not enough, to find customers and educate the consuming public to new uses is equally important.

Only a few aspects of the situation have been outlined, but the importance of regional studies becomes obvious. What changes are taking place in markets and marketing? How do regional production costs compare with each other? What is the state of the regional raw materials supply? These and numerous other questions become all-important in outlining plans for the future. Only by careful planning based upon adequate information can economic forces be controlled and their industrial and social hardships moderated. In the final analysis, our economic system is too dynamic and complicated to permit of the entire elimination of

difficulties caused by maladjustments of production -- but from the standpoint of both the individual producer, of the worker, and of the consuming public some thought must be given to ironing out long-run industrial fluctuations in the paper and pulp industry.

It is with the purpose of outlining the present situation of the paper industry in the Northeast and of suggesting some possible corrective measures that this paper has been undertaken. A truly worth-while study would fill several volumes -- but the writer has neither the experience nor the facilities to undertake such a program. One thing has, however, become clear and that is that a complete analysis of the situation undertaken by the industry as a whole would repay many times over the time and effort expended. Scientific research in pulp and paper has thrived; economic research -- equally important -- has lagged sorrowfully.

AN ECONOMIC HISTORY OF THE MODERN PAPER INDUSTRY  
IN THE NORTHEASTERN STATES

The Paper Industry Prior to the Use of Wood

No economic analysis of the modern wood pulp and paper industry would be complete without reference to certain significant moves in the early industry. Chronologically, the early industry referred to existed up to the period ending in the year 1859 -- a period during which practically no wood entered on a commercial basis, into the manufacture of paper. During that early period many materials were experimentally tried and some were extensively used for paper-making.

The papyrus of the Egyptians was the first material used-- and while the product was not a true paper, it approached closely the physical properties of that commodity. Papyrus early gave way to parchment made from sheepskin but



the raw material, and the treatment required before it could be used, was expensive and restricted its use to certain essential purposes. Around the year 200 B.C. the Chinese invented true paper, utilizing silk, rice, and bamboo as the basic raw materials. Linen, cotton, and straw were used in their turn, and while a great variety of other materials were tried, these three remained the chief constituents of paper up to the wood pulp period. Cotton in the form of rags is, of course, still used in sizable quantities in the manufacture of high grade papers, but compared to the quantity of wood used in paper-making it can no longer be considered of major importance.

Most significant in the history of materials for paper-making was the constant search for abundant and low cost materials during the early period to meet the great potential consumer demand for paper. When human wants greatly exceed the supply of an essential commodity, it is certain that a vigorous search will go forward to find means of supplying that commodity. Thus, in the history of paper the search eventually resulted in the adaptation of wood as the new and basic raw material. Nor is the quest for abundant and lower cost raw materials than wood at an end. Whenever, and wherever a paper-making material exceeding wood in its economic advantages is found, a reallocation of the paper industry as severe and sudden as the subsequently described shift from rags and straw to wood will occur.

In the first half of the 19th century, linen, and to a lesser extent cotton rags and straw were in great demand for paper-making. All linen used in the United States was imported and, because of its limited source of supply, high priced. This scarcity of raw materials and consequent high price of paper confined the use of that commodity to specialized purposes, and the industry remained comparatively small in size.

Nor did the United States stand alone in this serious raw material situation. Few paper producing countries had ample supplies of linen rags at home. The resulting scarcity of paper was hardly compatible with a world in which science was making tremendous strides. More than ever a medium for the transfer and preservation of human ideas and thought was needed. Thus the 19th century saw the search for new raw material go forward even more vigorously than formerly. By the middle of the 19th century these efforts had met with a great measure of success. In 1840 Friedrich Keller invented the process for manufacturing groundwood pulp. This development was followed in 1854 by the soda process for wood pulp manufacture, and in 1866 by Tilghmann's sulphite wood pulp process. Wood was now economically suited to paper manufacture.

#### The Transition to Wood

As has been implied, the transition from rags and straw to wood was sudden. The political events of the period shortly before the Civil War had stimulated the desire for news, and for a time straw entered the manufacture of newsprint in great quantities. But that material had great shortcomings. It was difficult to process and did not lend itself well to the manufacture of a good sheet of newsprint by machine.

The modern type of paper machine had been perfected as early as the year 1827. In the two decades following, the industry underwent rapid mechanization. By 1850 only two handmills remained in the United States while 441 machine mills were in operation.<sup>(16)</sup> The total annual output of paper during the period was small -- only 78,000 tons were produced in 1850. Only an abundant raw material was lacking to transform the small industry into one of mass production methods. The machines had been perfected, ideal production sites were available, and an enormous potential market for paper lay waiting. The year 1859 marks the end of the old era of the paper industry and the beginning of the transformation

to mass production methods in many divisions of the industry. In that year wood began to enter on a commercial basis as the raw material for paper. Development was slowed somewhat by patent control on the wood pulping processes, but by 1880 these patents expired and the industry hit its real stride of expansion.

#### The Establishment of the Industry in the Northeast

At first spruce was the only wood technically adapted to the newly developed mechanical and sulphite processes. Spruce was easy to grind, long fibred, light colored and free from gums and resins -- characteristics necessary in a wood to be pulped by grinding or by the sulphite method. Hardwoods were used with the soda process, but the total output of that type of pulp was relatively small in comparison to the other kinds of pulp. This factor of wood, while of primary importance in establishing the industry in the Northeast was supplemented by other natural factors. That region had, besides the vast spruce and hardwood forests, easily accessible paper consuming markets, transportation facilities that had reached the highest stage of development of any region, plentiful and pure water supplies so necessary to paper-making, and easily developed water power sites at hand. In addition, the network of drivable waterways in the region formed an almost perfect low cost primary transport system for moving pulpwood from stump to mill -- no small item in those days of animal power in the woods. In other words an optimum set of economic conditions for plant location, not found in any other region, existed in the Northeast.

By 1900, pulp and paper mills were scattered throughout the Northeast, and paper production in that year reached 2,000,000 tons. At about that time the industry began to expand to the Lake States where good markets and economic factors similar to those of the Northeast existed and up to 1920 the two regions produced nearly all of the nation's supply of paper.

DEVELOPMENT OF FOREST LAND POLICY IN THE  
NORTHEASTERN PAPER INDUSTRY

The history of the early lumber industry in the Northeast is closely related to the later established pulp and paper industry. The history will bear some recounting here in order to show the sudden change in the utilization of the Northeastern forests as spruce became increasingly valuable for pulpwood as well as the methods by which the paper industry acquired its forest holdings.

The forests of the Northeast have been cut more or less continuously since the first lumber mill was established in New Hampshire in 1623. Up to that year the New England Colonies had been regarded as a timber storehouse by Britain -- to be tapped only if the supply of timber from the Scandinavian countries was curtailed. However, with the population of the Colonies increasing rapidly, land had to be cleared, lumber was needed for domestic purposes, and as a commodity of trade for foreign goods. With the forests the major resource of the Colonies, and white pine a valuable commodity of international trade, a large domestic lumber export business was built up.

The growth of the lumber industry after 1623 was, therefore, rapid. By 1663 nearly 100 sawmills were in operation in the New England Colonies alone. The number of sawmills increased steadily -- 1381 mills were in operation in 1840 in Maine alone<sup>(2)</sup> and 6356 mills in New York in the same year.<sup>(1)</sup> Except in the more inaccessible areas of the Northeast, a similar expansion took place throughout the region. After 1840 the total number of sawmills began to decline, and by 1930 only about 400 sawmills (mostly portable and small) were operating in New England.

Shortly after the American Revolution the newly formed states were badly in need of money for the treasuries depleted by the long war, and new lands had to be opened to settlement. To solve these problems a liberal

policy of public land sales was embarked upon and the lands sold for what they would bring. Large blocks were sold and today, nearly all Northeastern forest lands are in private holdings; the notable exception being New York State where a large area of forest land has been reacquired by the State and a potential source of income has been closed, apparently forever.

In a situation such as previously outlined, economically accessible stumpage could not remain long uncut. One might question -- what was left for the wood pulp industry after the many years of lumbering in the Northeast? Stewart Holbrook has perhaps given the best answer when he said:

"One should remember that it wasn't a dearth of timber that drove Maine men west. It was a dearth of white pine timber, something vastly different in those days. When they talked about lumber, by the Holy Old Mackinaw, they meant white pine, the veritable *pinus strobus* of the college professors, and only that .....  
..... Spruce they left as wholly worthless. That's why New England was logged all over again, and its wood production peak came in 1907, years after the pine soldiers had gone." (1)

The first record of commercial logging of spruce is on the Penobscot and Kennebec Rivers in 1845 and 1850 respectively.<sup>(2)</sup> Within a short period of years spruce became a species as valuable as pine had been in its "heyday" in the Northeast. Thus the history of forest utilization has repeated itself again and again. Tree species regarded as worthless one day become valuable the next. As lumbering declined in the Northeast and the pulp and paper industry took its place, the hitherto despised spruce assumed a position of great economic importance. Balsam, hemlock, first eastern and then western, and southern pine became increasingly valuable as technological

advances adapted them to paper-making and as the spruce supplies ran short of meeting the ever-increasing pulpwood needs. Hardwoods have always been important in soda pulps, but are now entering a stage of major usefulness in the sulphate and sulphite processes.

The early land disposal policy of the newly formed states resulted in large timberland holdings being built up rather than in small agricultural units. Only a small proportion of the total land area of the Northeast was marginal for agriculture -- the greater part being forest land (i.e. land suitable for forest growth only). The early lumber industry therefore accumulated large tracts, but skimmed the forest chiefly for the pine and to a lesser extent for cedar and hardwoods. With the inception of the wood pulp industry, these lands on which large spruce stands remained were rapidly bought up by the latter industrial group. By 1900 nearly all available spruce lands in the Northeast were blocked up in such private holdings. Maine is a significant example: estimates by the Maine Forest Service showing that 18 private holders own from 100,000 to 200,000 acres each, 10 own 200,000 to 500,000 acres each, 2 own 500,000 to 1,000,000 acres each, and 2 own over 1,000,000 acres. With the exception of New York State, over 70 per cent of the forest land of the Northeast is in private ownership.

The reasons for this early land acquisition policy of the paper industry becomes obvious when one considers the conditions of the day. High capital investments were necessary to establish pulp and paper mills -- averaging about five million dollars for the lowest capacity plant compatible with successful operation, not including investments in timberlands. Since it appeared that spruce was the only wood suitable to the bulk of paper production, it was necessary that the mills own the comparatively limited areas of spruce lands for several reasons. The possibility that spruce might be diverted to other uses had to be prevented; it was necessary for established mills to control the resource lest it fall into the hands of new

competitors; mill owned supplies were a protection against prohibitive prices in pulpwood sellers markets; and in general, to protect their capital investment and stay in business, the papermen felt that the lands must be closely held. To quote one able and prominent executive who has long been connected with a successful operating company in the Northeast:

"In the beginning of the wood pulp industry it was an established and approved policy, almost dogmatic, in fact, that ownership of pulpwood stumpage was necessary to round out and complete a successful paper manufacturing outfit."(29)

As a result of the above policy, over two-thirds of the eleven million acres of timberland held by the domestic paper industry in the United States lies in the Northeast.(36) Early in the game the industry realized the importance of obtaining a second cut from these lands. In many instances cutting to a diameter limit was practiced and most of the lands so handled have been cut twice over. Unfortunately, however, a great proportion of the lands were skimmed clean of spruce and have restocked to less valuable species.

Today the holdings of the Northeastern pulp and paper industry average  $3\frac{1}{2}$  cords per acre(36) -- a rather satisfactory state considering the intensive utilization which these lands have undergone and the important part they have played in the development of a great domestic industry.

SOME ASPECTS OF THE ECONOMIC AND BUSINESS DEVELOPMENT OF  
THE NORTHEASTERN INDUSTRY

Trust Movements

The acquisition of lands described in the previous paragraphs was closely related to certain business moves in the early industry. Business at the turn of the century was "trust conscious", mergers and monopoly were

the aim of many moves in American industry at that time. Certain divisions of the Northeastern paper industry seemed a perfect field for monopoly control. It appeared that if any individual, or group of individuals, could control the available spruce resources, and/or the economically located production sites, some divisions of the industry could be tied-up under centralized management. The protective tariff in effect on all papers made a monopolistic venture in paper seem singularly attractive.

The first major move in that direction was undertaken in the newsprint field when in 1889, thirty of the largest newsprint mills combined to form the International Paper Company. In the year of its inception this company controlled about 70 per cent of the total domestic newsprint production. The company acquired extensive timberland holdings in the Northeast, and for a period of years following 1900, seemed in a strong monopolistic position. In 1913 newsprint was placed on the free tariff list and the Canadian newsprint industry entered upon a stage of tremendous expansion and production. By 1922 the International Paper Company was producing only 18 per cent of the total domestic newsprint production and only 10 per cent of the total domestic consumption.

That company turned its efforts in several directions early in the century in an endeavor to counteract the Canadian forces which were becoming so apparent. With the rapid increase taking place in paper consumption and the fact that spruce continued to be the basic raw material for newsprint, the International Paper Company realized the necessity of acquiring additional pulpwood lands beyond those which they already held in the Northeast. It must be borne in mind, at the risk of repetition here, that almost all available spruce lands in the Northeast had been blocked up by 1900. Additional lands were, however, available within reasonable distances in Canada and the International Company entered upon an extensive policy of spruce stumpage acquisition in the Provinces. By 1909 the Company held lease



rights to stumpage on over 2,500,000 acres of Canadian forest lands.

A combination of events soon rendered these holdings valueless for use within the United States. Following a lead set by Ptolemy Philadelphicus twenty-two centuries ago when that monarch forbade the export of papyrus from Egypt, (3) the Canadian Government in 1910 placed an embargo on exports of pulpwood from Crown lands in Quebec, and followed with a similar embargo for Ontario in 1911. In view of the fact that the International Company's lease rights were confined to those Provinces and that the Company's mills were all located within the United States, the Dominion Government's Act was almost confiscatory in nature. At any rate the Canadian embargo and the United States Tariff Act of 1911 broke any hope of monopoly control of newsprint production by the International Paper Company or any other domestic producer.

The developments could not have been otherwise; natural economic forces were moving to change the newsprint production situation. The rapid increase in domestic consumption of that commodity exceeded any possible productive capacity of the domestic industry based upon the raw materials supply at home. With the impending embargo on Canadian pulpwood, the Tariff Act became a national necessity. Nor can the Canadian Government be really blamed for its taking advantage of any schemes to build up its domestic industry and utilize its natural resources. Shortly after 1911, new Canadian mills established themselves along the waterways of Ontario and Quebec and gained advantages of low cost water transport of raw materials to the mills and finished products to the markets, as well as the economies of new and efficient equipment. Spruce stumpage prices were extremely low -- specifically with the aim of building up the industry -- and gave the Canadian producers an additional competitive advantage.

By 1920 many independent producers of newsprint as well as many of the mills of the International Company shifted to the production of

higher grade papers on which a protective tariff was in effect and for which products their plants again became supra-marginal. In 1922 more than half of the International Company's revenue was derived from papers other than newsprint.

In the 1920's investigations for monopolistic practices in the newsprint industry were instituted by the Federal Trade Commission. These investigations were based on price leadership practices by the International and Great Northern Paper Companies. Had the investigations been carried on ten or fifteen years earlier, some cause for action under the anti-trust laws might have been found. The Federal Trade Commission failed to find any violations by the newsprint division -- the domestic group controlling too small a section of productive capacity to influence the price of newsprint. The reports revealed, however, that several of the companies, in search for new sources of revenue, had developed their power resources and entered the public utility field. Examination of the International Paper Company's balance sheet for 1936 indicates that one-fourth of that company's fixed assets are represented by power holdings. It was also brought out that the International Company had been buying heavily of the securities of newspapers and other publishers in order to assure a steady outlet for its products. In a series of financial difficulties undergone by the International Company in the late 1920's, it divested itself of these securities.

Table I indicates the extent to which Canadian newsprint production has entered United States markets since 1913:

TABLE I: NEWS PRINT AVAILABLE FOR CONSUMPTION  
IN THE UNITED STATES

Source: News Print Service Bureau

<u>Year</u>	<u>Tons</u>	<u>% Supplied by Canada</u>	<u>Year</u>	<u>Tons</u>	<u>% Supplied by Canada</u>
1913	1,482,000	15	1925	2,955,000	44
1914	1,567,000	20	1926	3,517,000	47
1915	1,552,000	24	1927	3,461,000	51
1916	1,707,000	27	1928	3,563,000	54
1917	1,824,000	31	1929	3,796,000	58
1918	1,759,000	34	1930	3,551,000	56
1919	1,895,000	33	1931	3,212,000	55
1920	2,193,000	31	1932	2,793,000	55
1921	2,000,000	33	1933	2,728,000	57
1922	2,451,000	37	1934	3,148,000	62
1923	2,778,000	40	1935	3,272,000	63
1924	2,821,000	42	1936	3,575,000	63

One other notable attempt at monopoly control was significant in the early Northeastern Paper Industry. In 1889, a combine was formed to corner the production facilities of the paperboard division. It differed essentially from the newsprint move in that the paperboard combine aimed at controlling the production sites rather than the sources of raw materials supply. This combine, the American Strawboard Company, acquired from 85 to 90 per cent of the paperboard mill capacity in the United States. The exact means of acquisition are unknown, but the purpose was clear, namely, suppression of competition from newcomers into the industry -- by sheer size of the combine. As paperboard consumption increased rapidly and technical advances made new materials suitable for paperboard production, new plant locations became economically feasible for production. Independents kept springing up, and uncontrolled price-cutting set in. The combine then attempted to suppress competition by absorbing troublesome independents, but the attempt failed.

In 1897, a new combine, the Standard Strawboard Company was formed, and by agreement with the American Company seemed to perfect control of the industry. Competition nevertheless developed and within two years after formation of the new company, prices broke sharply under pressure from new producers. Control by a joint selling agency was then tried in 1901 and 1903, but failed in each case.

These experiences led up to a more ambitious attempt to consolidate the paperboard industry. The new plan was to purchase all essential pulp plants as well as the plants engaged in production of the finished product. A new company, the Limited Box Board and Paper Company was created in 1902 to carry out the plan. The American Company was to be controlled by the purchase of a majority of its voting stock. The industry, laboring under severe competition, great overcapacity, and low prices, seemed as a whole favorable to the plan, and the combination was accordingly formed. Once again the vitality of new and efficient producers, coupled with the steady increase in consumer demand for the product, wrecked the apparently well-laid plans for monopoly control. After a series of financial difficulties, the combination went into receivership in 1908, and reorganized in smaller form as the Limited Box Board Company.

Yet further attempts were made at consolidation of production facilities in the paperboard field, but each failed. By 1919, the several times reorganized combine controlled but 30 per cent of the paperboard production as compared to 85 to 90 per cent control thirty years earlier. Since 1919 no new combinations have been attempted; the futility of such moves in the paper industry is well recognized.

Trust movements in the industry have been notable in their failures. The reasons are quite obvious. In the case of the International Paper Company, cornering of the raw material resource was only a temporary measure of control. The paperboard combines failed to recognize the fact

that whatever economies there may be in paper production pertain less to size than to location. In both trust movements the vigor and growth of the young industry was overlooked by the combines -- an economic circumstance which will "wear-down" and break any monopoly. One other point was significant -- technological developments constantly made new materials available for paper-making and gave new producers definite cost advantages in production as well as making available new production sites closer to consuming markets.

It will be noted that attempts at industrial combination were made only in the field of bulk paper products. In the higher grade and specialized papers division, certain cost and marketing elements inherent in the product precluded any monopolistic moves. For manufacture of the higher grades a wide variety of plant sites were available since the delivered costs of raw materials to the mills formed only a minor part of the cost of the finished product -- in contradistinction to the bulk grades where raw materials costs are all important.

#### Recent Expansion of the Industry

The recent expansion of the industry, particularly in the South, has resulted in a considerable duplication of plant. Kraft paper production, of that region, has almost wholly replaced the wrapping and bag paper production formerly enjoyed by the Northeast. There is also the threat of severe competition in other grades -- a situation which is discussed at a later point in this paper. It is estimated that present productive capacity for all papers could well take care of any increase in consumption for the next decade. This excess capacity has placed many divisions of the industry in a state of economic instability burdened with high overhead costs and an inelastic source of supply.

So far as developments in the industry of the past two years are concerned, the year 1937 again saw paper production in the United States exceed all previous highs. The great expansion was almost wholly due to expansion of kraft paper and paperboard output in the Southern states. In 1936 book and writing paper production increased, but did not equal the production of 1929. In the year 1937, however, these grades exceeded any previous year's production. Part of this production came about through shifting of grades by mills in the Northeast and Lake states, part of it through utilization of previously unused capacity, and only a small part of it due to new capacity installed.

As was brought out recently by Mr. Boyce, the great expansion in kraft paper and paperboard was mainly due to the rush for the best economic mill sites in the South, and only partly on account of foresight on the part of investing capital as to business conditions and future paper demand. Fortunately the trend of consumption of these grades has closely approximated the progressively increasing capacity and through 1936 and 1937 that division has had no major difficulties in finding outlets for its products. One cannot help but speculate, however, whether the history of the 1920's, with its bankruptcies and economic stress in certain divisions, will not be repeated in the South. Idle capacity in the wrapping paper division stood at 14 per cent and 12 per cent respectively in 1936 and 1937. Idle capacity in paperboard stood at 16 and 14 per cent respectively in those same years. Figure 1 shows production and idle capacity of the industry from 1923 - 1937. It is significant that even in the record years of 1929, 1936, and 1937 a sizable amount of over-capacity exists in the industry.

# CAPACITY AND ACTUAL PRODUCTION OF PAPER MACHINES UNITED STATES 1923-1937

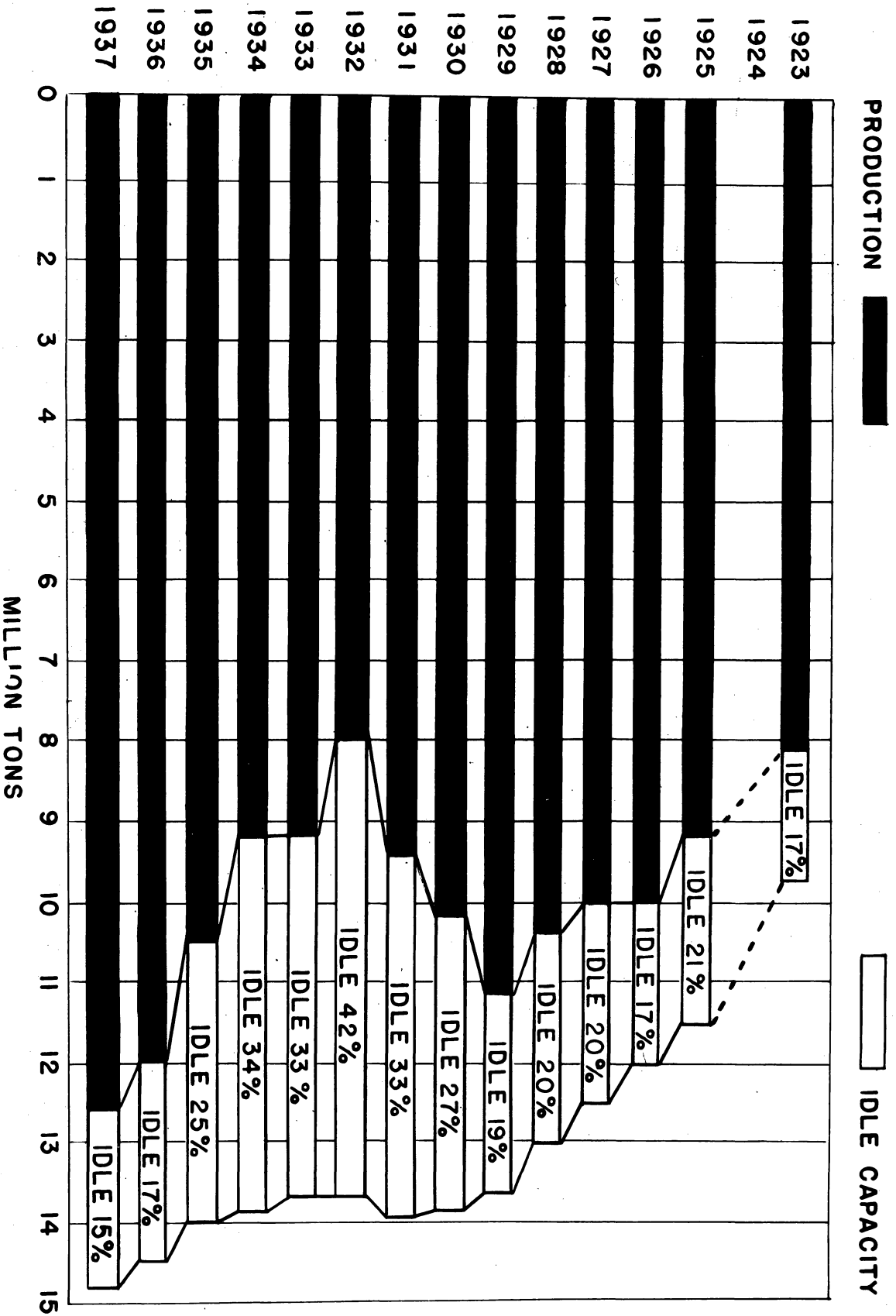


FIG 1

The paper industry as a whole began production on the high crest of a wave in 1937, reached its peak in the Spring, and fell off sharply towards the end of the year. Average operation of the industry in the first five months of 1937 stood at better than 90 per cent, the highest sustained rate for any similar period in the past. Production by December, 1937, had, however, fallen off to 55 per cent of capacity, with the average for the year at 85 per cent.

There is now building to go into operation shortly, new capacity as follows:

Paperboard .....	450,000 tons - annual
News Print .....	46,000 tons - annual
Book Paper .....	23,000 tons - annual
Specialties and Miscl.	47,000 tons - annual
Total .....	556,000 tons - annual

TABLE II

Summary of Capacity of the Industry - All Papers

1936 (Actual) .....	14,458,090 tons
1937 (Available) .....	14,753,000 tons
1938 (Begin.) .....	15,253,000 tons
1938 (End.) .....	15,809,000 tons

Thus there will be an increase of almost ten per cent in capacity from 1936 to 1938 -- prediction of the results had better not be attempted.

General Financial Disturbances

The very nature of the industry requires a structure built up of high capacity plants resting upon large capital investments and extraordinary slow turnover of capital. Normal turnover of fixed capital in the industry may take from one to three years, and up to thirty years may be required to amortize a large mill. A company with its financial structure resting upon paid-in stock can defer certain charges in periods of low earnings, but most paper companies which started during periods of major expansion, emerged with financial structures resembling inverted



pyramids -- heavy bonded indebtedness overbalancing the paid-in capital of the companies. Such financing has applied equally to the Canadian industry as to our own. The heavy bonded indebtedness has rendered capital structures too rigid for safety, and has, in fact, been responsible for the financial vulnerability of many companies. Heavy fixed charges on outstanding bond issues have been difficult to maintain in periods of over-capacity (due either to new plants or decline in consumer demand) and in 1933 resulted in financial failure of some of the largest paper companies in the United States and Canada.

Certain divisions of the industry, as the writing and book paper groups have, however, maintained a comparatively stable financial structure for years. In contrast to other divisions, particularly bulk paper, the producers of the higher and more specialized grades have shown little tendency to expand productive capacity when enjoying periods of full utilization of plant.

Federal Trade Commission reports indicate that past attempts by various divisions of the industry to bring about economic stability by fixing prices have failed. The solution seems rather to lie in the avoidance of sudden and excessive overexpansion, and the re-establishment of well located woodlands to reduce raw material costs. Such action lies, of course, in the hands of the industry itself -- first, by concerted action on the part of the entire industry, and second by action of the individual companies.

INTEGRATION OF THE WOOD PULP AND PAPER  
INDUSTRY IN THE NORTHEAST

General Discussion

Three classifications exist as to the manner in which paper companies are industrially organized. Those mills producing paper only

and purchasing their pulp supplies on the open market are designated as converting mills, those which purchase their wood supplies but manufacture both pulp and paper are designated as self-contained, while the third group, integrated mills, produce both pulp and paper and control their own raw materials supply. Needless to say, the latter group may purchase part or all of its pulpwood under favorable circumstances from outside sources.

So far as the Northeastern industry is concerned, only certain divisions find it advantageous (at the present time, at least) to maintain truly integrated establishments. The varying percentage distribution which direct costs, either material or labor, comprises of the total costs of production of the different kinds of paper determines the advantages of vertical integration. The economies of vertical integration are particularly pronounced in the production of those papers which are made in large uniform quantities, as wrapping paper, and newsprint. This generalization is, however, not always true. Geographic factors may contribute cost variables which affect the degree of integration possible, either through the general higher proportionate transportation cost on paper than on pulp or pulpwood, or because of the wide separation of the sources of necessary raw materials, as in paper manufacture requiring large quantities of waste paper as well as fresh pulp. As a general statement, the greater the proportion which pulpwood costs make up of the total production costs, excluding certain fixed charges, the more pronounced are the economies of vertical integration. In the manufacture of higher grade papers, on the other hand, raw material costs become less important as other costs (labor, special machine costs, and sales expense) rise, and vertical integration becomes less important. This explains the fact that England and France, though lacking in adequate wood supplies, are nevertheless of considerable importance in the manufacture of certain high grade papers.

In the beginning, the Northeastern paper industry was almost completely integrated; production centering around the bulk grades of papers. As intense competition developed, first within the region, and later from other regions and foreign countries, and as wood supplies in the Northeast diminished, many Northeastern mills progressively shifted production to higher grades of paper. "Shifting of grades" is a phenomenon peculiar to the paper industry. Mills which become submarginal for production of a definite grade of paper -- either through inefficiency of old machinery or depressed prices, may shift production to a new and higher grade of paper on which a wider margin per unit of output is possible. Self-contained, or integrated plants in shifting to higher grades, have found it advantageous, in many cases, to shut down their digesters and become converting mills. Such has, in general, been the trend in the Northeast -- and the industry in that region seems to be tending towards one made up chiefly of converting mills.

#### Degree of Integration in the Northeast

Table III shows that there are 353 paper mills in the Northeast as compared to 110 pulp plants. Many of the paper plants use rag stock and waste papers and it is impossible to show a true comparison of the number of mills using wood pulp and the number of wood pulp plants.

TABLE III: NUMBER OF FIRMS OWNING MILLS, AND  
NUMBER OF PULP AND PAPER MILLS -  
NORTHEASTERN STATES-1936

Source: Lockwood's Directory of the  
Paper and Allied Trades

<u>Location</u>	<u>No. of Firms</u>	<u>No. of Paper Mills</u>	<u>No. of Pulp Mills</u>	<u>No. of Ground- wood Mills</u>	<u>No. of Sulphite Pulp Mills</u>	<u>No. of Soda Pulp Mills</u>	<u>No. of Sulphate Pulp Mills</u>
Maine	21	29	33	17	12	3	1
New Hampshire	21	28	7	3	4	0	0
Vermont	10	10	3	3	0	0	0
Massachusetts	61	96	3	1	1	1	0
New York	112	129	53	39	10	4	0
Pennsylvania	<u>53</u>	<u>61</u>	<u>11</u>	<u>1</u>	<u>3</u>	<u>6</u>	<u>1</u>
Total	278	353	110	64	30	14	2

It is obvious, however, that with the exception of Maine, the number of paper mills in the Northeast is out of all proportion to the number of pulp mills.

TABLE IV: PULP PRODUCTION, CONSUMPTION,  
AND MILL CAPACITY IN THE  
NORTHEAST IN 1935

Source: U.S. Tariff Commission

Quantities in Thousands of Tons

<u>Kind of Pulp</u>	<u>Production</u>	<u>Consumption</u>	<u>Excess of Production(+) Excess of Consumption(-)</u>	<u>Rated Normal Capacity of Mills</u>
Sulphite	602	1251	-649	913
Sulphate	--	346	-346	80
Soda	249	249	--	432
Groundwood	797	901	-104	1424
Other	<u>16</u>	<u>18</u>	<u>-2</u>	<u>--</u>
Total	1664	2765	-1101	2849

Based upon actual production and consumption of wood pulp in 1925, Table IV shows that only about 50 per cent of the region's wood pulp

needs were met by production of Northeastern mills. At full capacity 75 per cent of the region's needs could have been met by its mills -- but for reasons previously discussed, it was advantageous to purchase pulp from outside sources.

#### Some Aspects of Integration

In the final analysis, the possibilities of cutting costs in many divisions of the industry through efficient and scientific handling of mill owned woodlands to supply the mill's needs is too important a prospect to be overlooked by the industry. There are numerous advantages in complete vertical integration and control of the raw material sources -- four of which advantages are summed up as follows:

1. Getting one's material at cost and cutting of overhead charges through combined management.
2. Production of the proper kinds of material.
3. Reliability of raw materials supply -- not subject to the instability of sellers markets.
4. Savings of time and money through elimination of negotiation and higgling, contracts, stimulation of the market by sellers, testing, and other work involved in buying and selling.

In the Northeast where the industry owns sufficient acreage to supply a great, (or perhaps entire) part of its pulpwood needs, expenditures of comparatively small sums for the management of woodlands would result in tight, low unit overhead, management units.

(Actual costs of management are discussed at a later point.) In general, there can be only one objection to mill-owned woodlands and that is summed up by someone who said "if you want a thing done cheaply hire a specialist who does that thing for half the world and on a mammoth scale." The objection loses its weight in so far as the

paper industry is concerned. A managed area to supply the needs of the average Northeastern mill would be close to an ideal economic unit; neither too small to carry the necessary charges, nor too large to prove unwieldy. Viewed in the light of the previously stated advantages of integration, it is obvious that certain intangible assets, not appearing on the balance sheet, would accrue to any company supplying its own wood on a perpetual basis. It might be argued, of course, that in times of depressed markets, mills which purchased all their pulpwood or wood pulp might enjoy lower costs than those obtainable by mills owning their own sources of supply. The possibility of such fluctuations cannot be denied, but in view of the past trend of pulpwood prices as shown in Table 5, it will be seen that the trend of pulpwood prices has been steadily upward, showing but few downward fluctuations. Foreign sulphite wood pulp prices, on the other hand, have remained practically level since the war. (Figure 3).

TABLE V: AVERAGE PRICES OF SPRUCE PER CORD - DOMESTIC AND IMPORTED -- 1899-1906

<u>Year</u>	<u>Domestic</u>	<u>Imported</u>	<u>Year</u>	<u>Domestic</u>	<u>Imported</u>
1899	\$4.82	\$6.51	1926	\$17.38	\$19.96
1904	6.89	8.49	1927	17.11	19.58
1907	8.55	9.60	1928	17.04	19.21
1908	8.76	10.60	1929	16.79	19.89
1909	9.32	11.34	1930	16.38	18.55
1914	9.45	11.73	1931	15.14	17.87
1916	9.35	11.47	1932	12.65	14.57
1917	11.98	16.52	1933	10.56	12.03
1918	15.38	19.25	1934	10.18	11.94
1919	17.20	20.85	1935	10.20	12.53
1920	19.97	26.78	1936	10.54	12.31
1921	21.68	27.98	1937		
1922	18.11	21.87			
1923	18.20	20.34			
1924	18.21	20.37			
1925	17.87	20.62			

1899-1925 - Compiled from Bureau of Census and Forest Service Figures.

1926-1935 -

(The costs of raising wood on mill owned lands is calculated in a following section.)

PULP PRODUCTION IN THE NORTHEAST

Trends and Distribution of Productive Capacity

The Northeast is still the most important pulp producing region in the country both in quantity and value. Up to 1900 the region produced practically all pulp consumed in the United States -- only Michigan and Ohio producing any pulp in appreciable quantities outside of the Northeast.

Table 6 shows actual pulp production in the Northeast for certain specified years from 1899 to 1936. It will be noticed that the proportion which Northeastern production makes up of the total has been decreasing steadily.

TABLE VI: WOOD PULP PRODUCTION BY SPECIFIED YEARS --  
1899 TO 1936. NORTHEASTERN AND TOTAL  
UNITED STATES PRODUCTION

(Thousands of Tons)								
Year	Me.	Mass.	N. H.	Vermont	N. Y.	Penn.	Total Northeast	Total U. S.
1899	232	25	120	65	395	85	921	1,180
1904	457	28	174	61	606	83	1,409	1,922
1909	604	26	213	59	686	136	1,723	2,491
1916	852	19	341	74	787	217	2,291	3,435
1919	917	33	232	86	812	216	2,295	3,518
1924	895	30	217	46	755	217	2,161	3,723
1929							2,176	
1930							1,927	
1931	889	24	90	26	467	160	1,748	4,409
1932	765	14	*	*	354	130	1,409	3,760
1933	779	12	79	18	394	124	1,456	4,276
1934	833	10	*	14	365	128	1,507	4,436
1935	848	*	*	13	404	152	1,664	4,926
1936								
1937								

\* Included in Total

Sources: 1899-1924 - American Forests and Forest Products.  
1929-1930 -  
1931-1934 - Agricultural Statistics-U.S.Dept. of  
Agriculture (1937)  
1935 - Bureau of Census.

Pulp production in the Northeast in the past two decades has remained practically level, however -- but again this is an actual decrease

since paper production in the region has increased tremendously during that period. The increasing need for pulp has been met mainly by imports from foreign sources. Figure 2 shows that in 1930, pulp imports into the Northeast exceeded production in that region. The reason is chiefly one of pulpwood costs, the Northeastern industry finding it cheaper to import pulp than to utilize its full pulp capacity. In view of low wood pulp prices from foreign sources, there is certainly no incentive to expansion of present capacity in the Northeast. The trend of foreign sulphite prices is shown graphically in Figure 3. The import situation is taken up in greater detail at a later point.

### Sulphite Pulp

In the field of sulphite pulp production, the Northeast produces about 50 per cent of its needs.<sup>(36)</sup> Except for about 5 per cent from the Pacific Northwest, the Northeastern deficiency is met from foreign sources. Since sulphite pulp is the most important to the industry in the Northeast -- and doubtless will continue to be -- it is doubtful whether production of that grade of pulp will decrease to any great extent in the future. Though it is largely a question of opportunity costs, all far-sighted paper mill executives must realize the consequences of any extensive "abandonment" of pulp production in the Northeast -- a course which would throw the industry in that region at the mercy of a pulp seller's market.

Spruce remains the most desirable wood for sulphite pulp and the Northeast is peculiarly fitted to the growth of that species. The paradox of the situation is that the region shows exceedingly high unutilized pulp capacity, 42 and 34 per cent in 1934 and 1935 respectively, while few moves are made to grow wood to increase the utilization of the idle plant. In some cases the pulping equipment may be obsolete, but the production sites remain the most economically located in the country (ignoring, of course, the present pulpwood situation in the region).



# CONSUMPTION, PRODUCTION AND IMPORTS OF SULPHITE PULP UNITED STATES 1929-1936

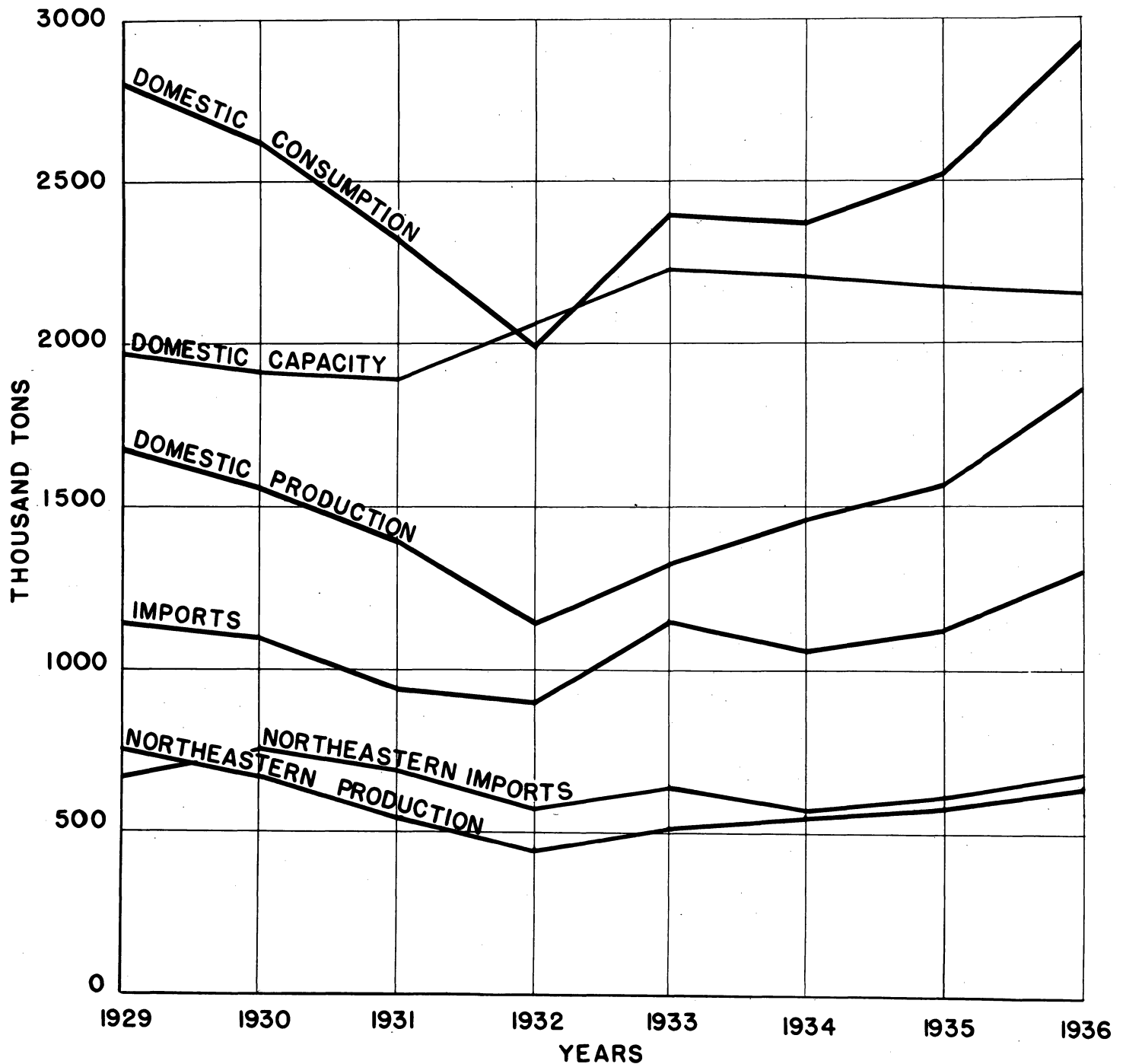
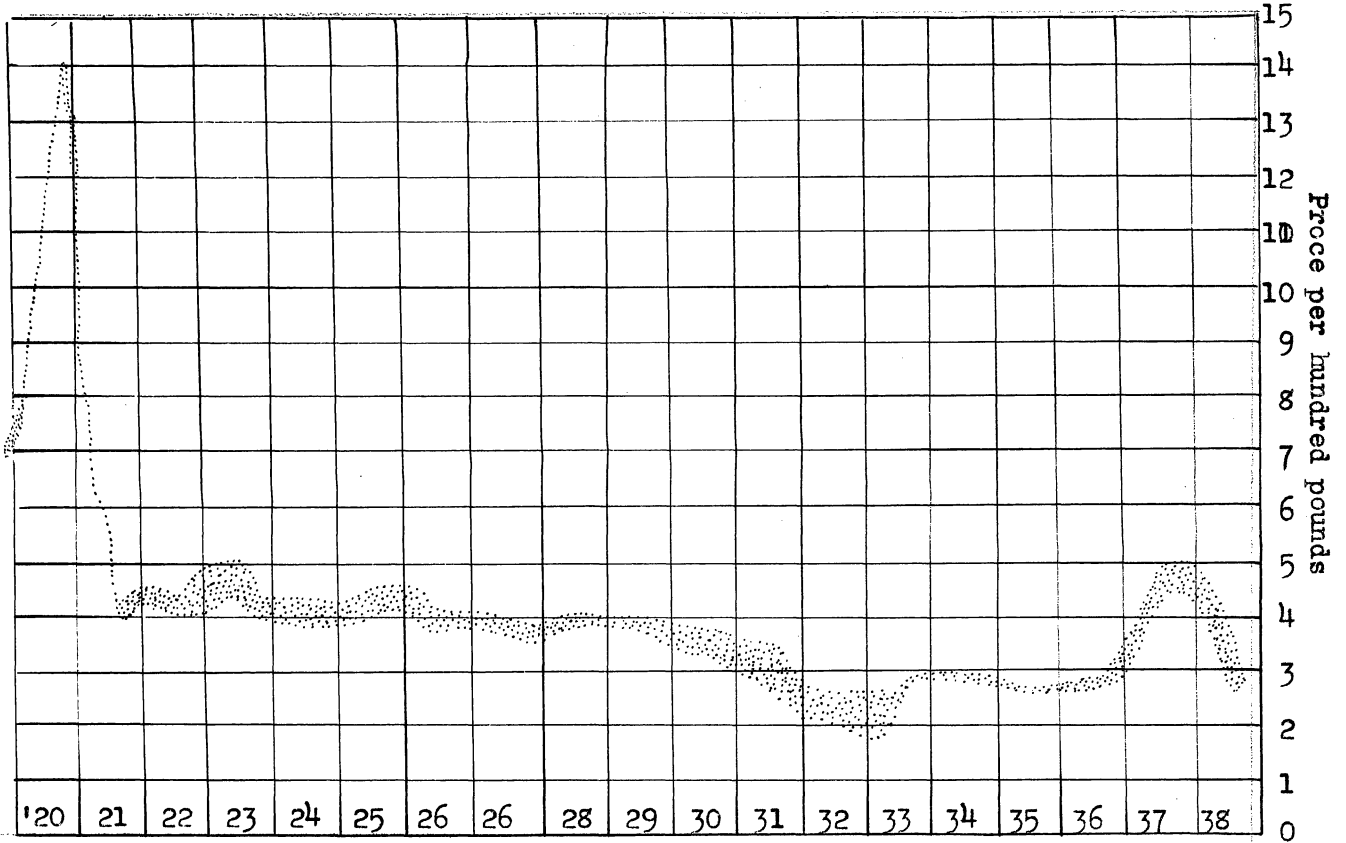


FIG 2

TREND OF FOREIGN SULPHITE  
PRICES

(1920 - 1938)



TREND OF FOREIGN SULPHATE PULP PRICES

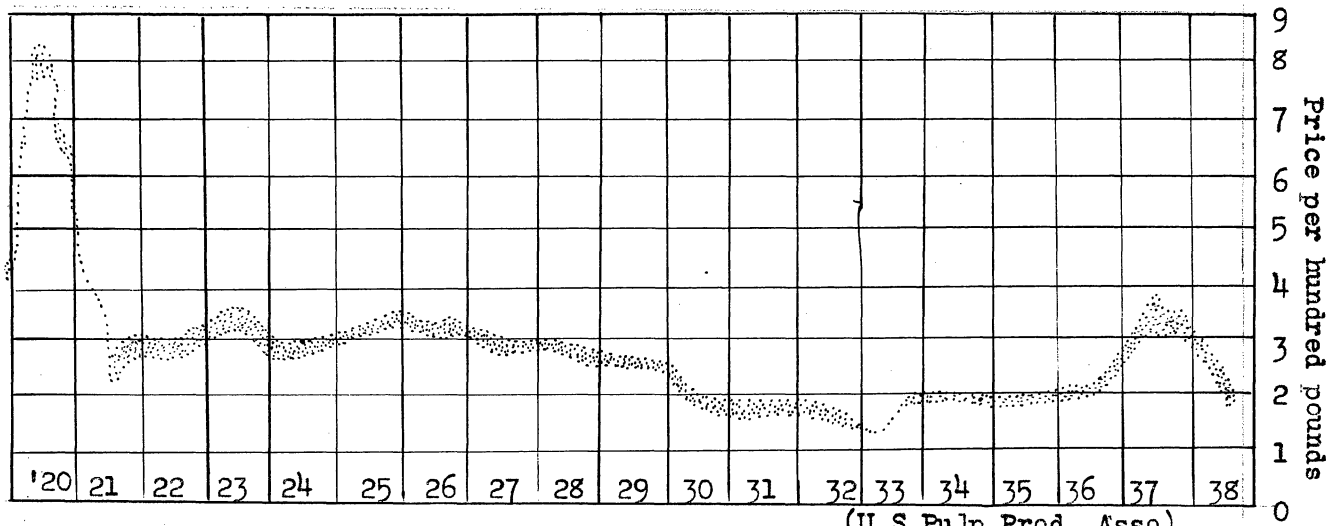


Fig. 3

(U. S. Pulp Prod. Asso)

Actual domestic distribution of sulphite production facilities is about as follows: Maine, New Hampshire, and New York combined had 36 per cent of the nation's 1935 capacity of 8,000 tons daily. Washington and Oregon followed with a combined total of 29 per cent of national capacity. Wisconsin and Michigan combined made up 22 per cent, and the remaining 13 per cent of capacity was scattered through seven other states. (26)

### Sulphate Pulp

No sulphate pulp of any important quantity was produced within the region, although 346,000 tons were consumed in 1935. (36) Sulphate pulp production has been largely taken over by the Southern industry where it is nearly all converted to bulk paper products in self-contained plants. Practically the entire domestic consumption of sulphate pulp is now met by the South -- the Pacific Northwest alone supplying its own needs. Only minor quantities of sulphate pulp have been imported in recent years -- and in all probability Southern competition will soon cause all foreign exports of sulphate to the United States to cease.

The actual distribution of productive capacity of this grade is largely confined to a comparatively few states -- Louisiana, Washington and Virginia having between them one-half of the national capacity. Idle capacity for the region in this grade stood at 100 and 85 per cent respectively in 1934 and 1935. (36)

### Soda Pulp

The Northeast meets all its own needs of soda pulp. Depending wholly upon hardwoods, the soda process is particularly well-suited to the region. Four states, Pennsylvania, Maine, New York, and Mississippi have about 53 per cent of the national capacity. (26)

Groundwood Pulp

Actual imports of groundwood as such are small, but very extensive imports are made from Canada in the form of newsprint. Maine, Massachusetts, Vermont, New Hampshire and New York have between them 59 per cent of the national capacity; Wisconsin, Minnesota, and Michigan have 23 per cent; and Washington and Oregon have 16 per cent.<sup>(26)</sup> Idle capacity in this grade in the Northeast was extremely high in 1934 and 1935; 50 and 44 per cent respectively.<sup>(36)</sup>

TABLE VII: COMPARISON OF PRODUCTION AND APPARENT CONSUMPTION  
IN THE NORTHEAST BY KINDS OF PULP

Source: U. S. Tariff Commission

(Thousands of Tons)

<u>Kind of Pulp</u>	<u>1933</u>		<u>1935</u>	
	<u>Consumption</u>	<u>Production</u>	<u>Consumption</u>	<u>Production</u>
Sulphite	502	1,222	602	1,251
Sulphate	Negligible	326	Negligible	346
Groundwood	718	831	797	901
Soda	209	206	249	249
Other	<u>30</u>	<u>31</u>	<u>16</u>	<u>18</u>
Total	<u>1,459</u>	<u>2,616</u>	<u>1,664</u>	<u>2,765</u>

INTERNATIONAL FACTORS IN PULP PRODUCTION AND  
COMPETITION

The story of the world's pulp and paper industry and its international interplay goes farther than the manufacture of paper and pulp; the more fundamental story is concerned with the production and availability for use of the raw materials used for paper-making. Under present conditions of production this means the story is one of opportunity costs --

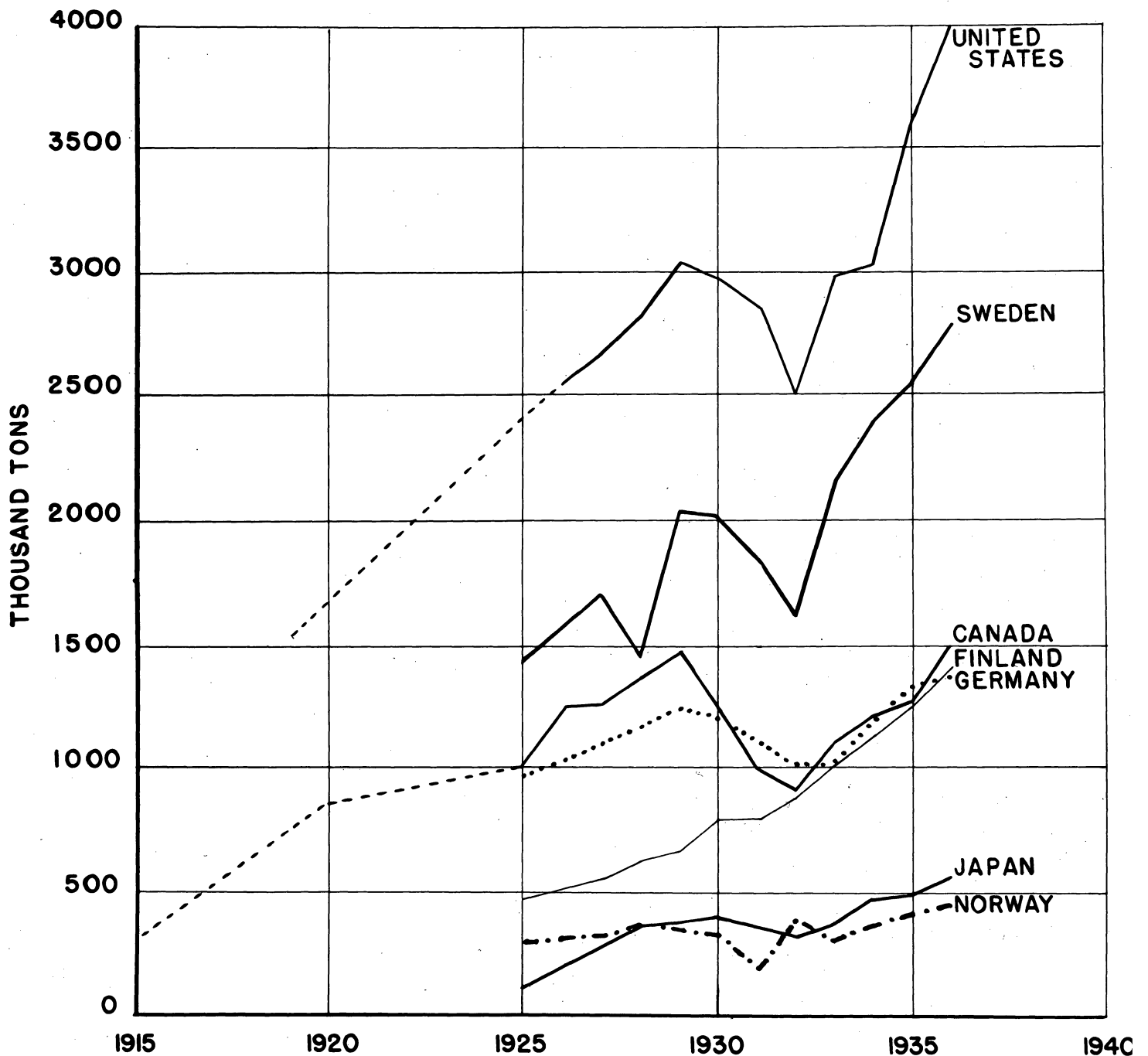
or more specifically of pulpwood supplies, international trade in woodpulp, and the respective costs of pulpwood in the various competing countries.

Moreover, the competition between wood and other materials for pulp is bound to become more severe as the demand for paper grows in the interior of countries which have limited wood supplies. To date, however, the use of straw in Germany, Holland, Belgium and the United States, of esparto in England, France, and Italy, and of rags in all countries making rag content papers is limited to a small part of the world's needs. Only the use of waste paper, developed in the United States and other paperboard producing countries, especially Germany, has shown a growth comparable to that of wood pulp.

Despite this, however, the substitution of other materials for wood in paper-making cannot be lightly dismissed. Wherever and whenever comparable and perhaps better pulps can be manufactured in large quantities from other materials than wood at lower costs delivered at the chief centers of consumption, substitutions will become serious. But the combination of worldwide overproduction and rapid technical development in wood use is making substitution constantly more difficult, for the cost of wood pulp is being reduced. At the same time this combination has stimulated a far-reaching search for cheaper pulp materials. While this search is confined largely to cheaper kinds and forms of wood, it will undoubtedly extend to other materials, particularly sawmill wastes in the northern countries and rapid growing woody plants in the tropics. But the present situation hinges upon pulpwood and it is likely that wood will be a determining factor in world paper trade for some time to come.

The production of wood pulp is largely confined to those countries which possess extensive stands of spruce, or are able to import spruce pulpwood from neighboring countries. Although the use of sulphate pulp, manufactured from wood other than spruce, has grown remarkably in the recent

# CHEMICAL WOODPULP PRODUCTION BY PRINCIPAL PRODUCING COUNTRIES AND YEARS



**SOURCES:**

U.S. DEPT. OF COMMERCE  
 SWEDEN - STATISTIKA CENTRAL BRYAN-INDUSTRI BERATTELSE  
 CANADA - DOMINION BUR. OF STATISTICS  
 FINLAND - STAT. BUR. OF THE BOARD OF CUSTOMS  
 GERMANY - WIRTSCHAFTSGRUPPE DER PAPIER, PAPPEN, ZEITSTOFF - ERZUGUNG - BERLIN  
 JAPAN - JAPAN YEARBOOK - FOREIGN AFFAIRS ASSOCIATION OF JAPAN  
 NORWAY - LEAGUE OF NATIONS STAT. YEARBOOK

FIG 4

# CHEMICAL WOODPULP PRODUCTION BY PRINCIPAL PRODUCING COUNTRIES AND YEARS

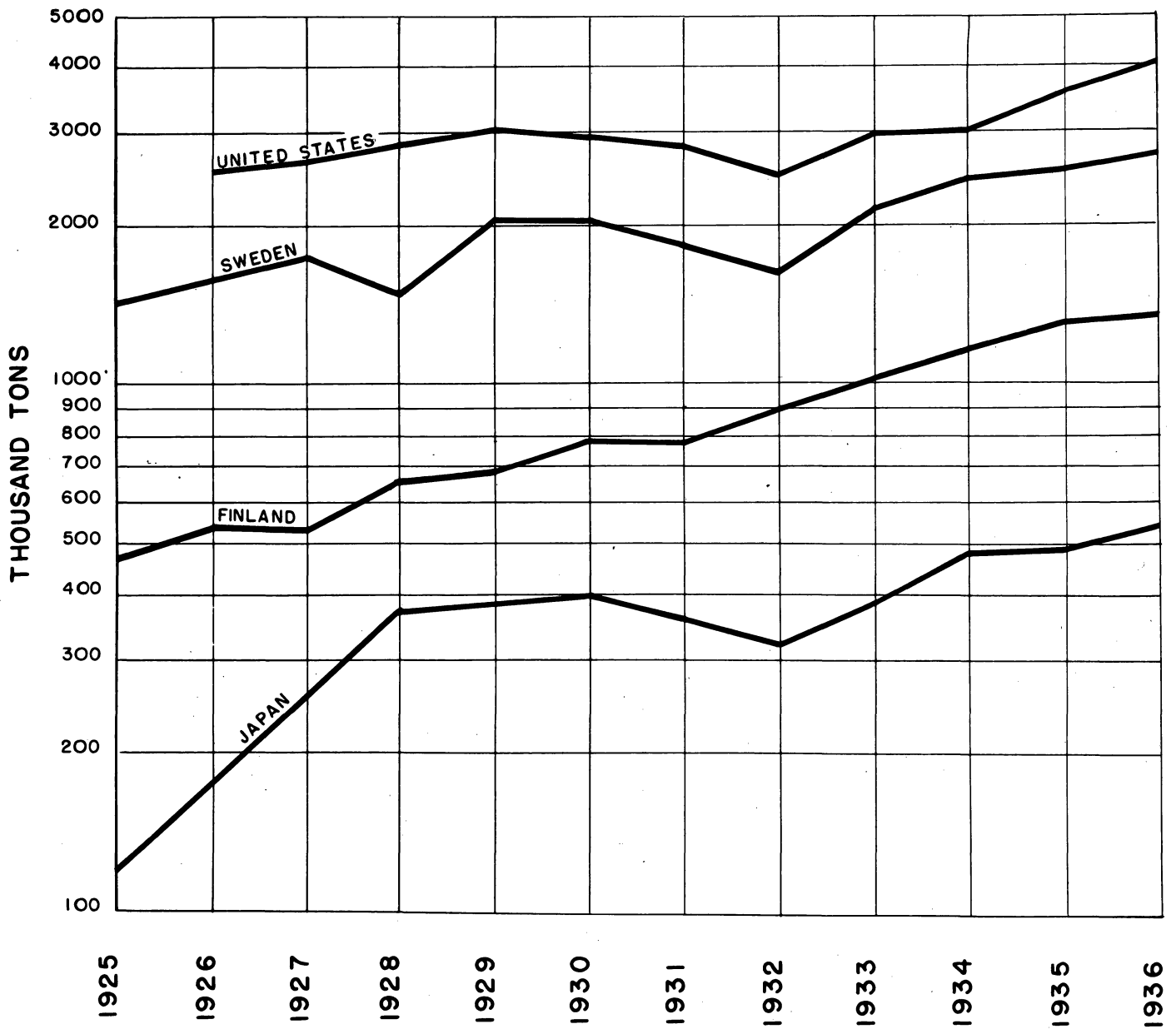
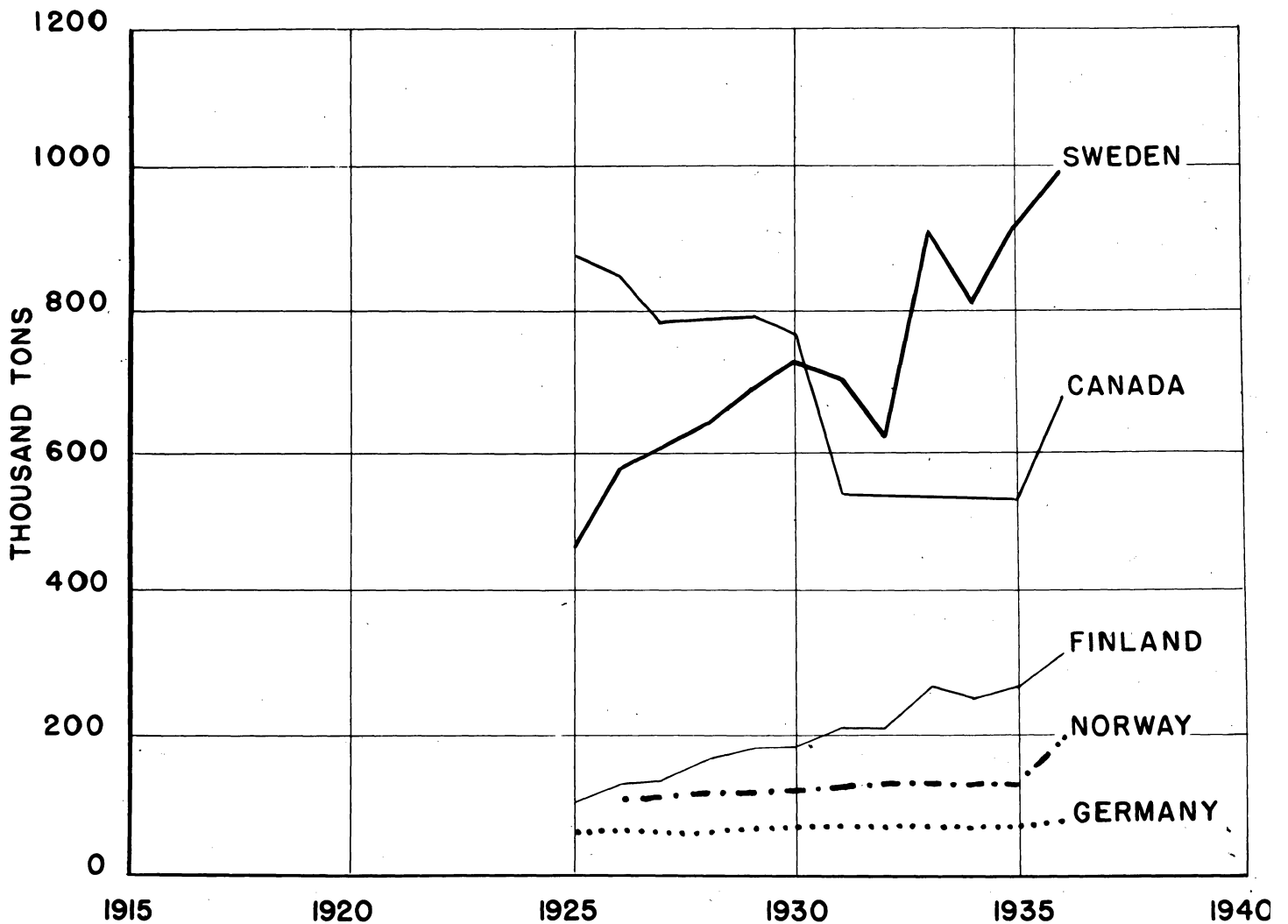


FIG 5

# UNITED STATES IMPORTS FROM PRINCIPAL PULP PRODUCING COUNTRIES ALL PULPS



SOURCE:  
U.S. BUR. FOR. & DOM.COMMERCE

FIG 6



past and is at the present in the midst of its most rapid period of growth, especially in the United States, Finland, and Sweden, the pine forests of the world have not yet become a dominating factor in the industry. Although a wide change can be expected in pulp production processes, the relative position of the pulp producing countries will be changed but little except that of the United States, for the spruce producing countries are the chief producers of all softwoods that enter into world trade either as wood or as pulp or paper. The United States with its vast pine forests in the South, and fir and hemlock forests in the West, occupies a unique position in the future world pulp situation.

In Figures 4 and 5 the trends of pulp production in the more important pulp producing countries of the world are shown. Large increases in production have taken place in practically all pulp producing countries; the most significant on a rate basis, however, occurred in Canada, Finland, and Japan. The Swedish output more than doubled during the period, while production in Germany, United States, and Norway increased at somewhat lower rates.

The dominating influence in this upward movement of production has been, of course, the tremendous increase in the consumption of paper in the United States, an increase which has been but partially met by domestic pulp production. Pulp from all the major producing countries in the world has flowed to the United States and competed in American markets with the domestic product. The competition of outside producers has been imminently successful as the rapid increase in American wood pulp and newsprint imports indicates. This trend is shown graphically in Figure 6. The protective tariff on paper other than newsprint has precluded foreign paper producers from competing to any great degree in that field in domestic markets.

The greatest increase in world production has occurred in chemical pulp. Mechanical pulp, while the least expensive to make, has not increased proportionately; it has shown significant increase only in Canada.

Mechanical pulp is dependent upon spruce, the most desirable and most expensive of all pulpwoods. Its use is devoted largely to conversion into newsprint paper; it is probable that between 75 and 80 per cent of all mechanical pulp produced in the world is used for newsprint. Although the consumption of newsprint paper has increased rapidly, the use of mechanical pulp is restricted to less than one fifth of the world's paper needs.

The chemical pulps, on the other hand, are being used to manufacture the bulk of the world's paper that is made from fresh pulp. The opportunity for increase is therefore greater. That this opportunity has been grasped by the leading pulp producing countries is indicated clearly in Figures 4 and 5.

Within the paper consuming countries which have insufficient timber to meet all their wood requirements, competition exists between domestic producers of wood pulp using both domestic and imported wood, wood pulp and paper imports, and other pulp making materials. Conditions of this competition vary also in different parts of the same country, especially in the larger countries. The United States, France, and Germany are the best examples of this type of competition.

Tariff walls handicap the imports of paper in the chief pulp producing countries, except in cases of conspicuous domestic insufficiency -- as the existing newsprint situation in the United States. The greater national economy in manufacturing wood pulp for export rather than pulpwood causes international trade in paper-making materials to consist largely of wood pulp. In the case of Canada and Russia, however, excess supplies of pulpwood in the process of liquidation have resulted in a rather substantial export trade being built up in those materials. Except for a few items of high grade papers, such as cigarette and hand-made papers, the American industry is then affected chiefly by wood pulp and secondly by pulpwood trade.

The outstanding factor in the relative competitive position in common markets so far as the individual pulp producing countries are concerned is

chiefly the cost of pulpwood. It is that item that makes up the greatest part of manufacturing cost as well as being the greatest single variable. Of course, other geographic, technical, and industrial factors play a part, but their influences are manifested to a greater extent in pulpwood costs than in manufacturing or distributing the final product. The chief interest of the world's pulp producing centers, therefore, is in comparative wood costs.

The determinants of pulpwood costs are by no means simple or limited. They are too complex, and somewhat beside the point, to be here discussed, but it is safe to say that since wood production costs (including transportation to the mill) vary the widest in the industry, the country and producer who has and can maintain these items at low costs has a marked advantage in world trade.

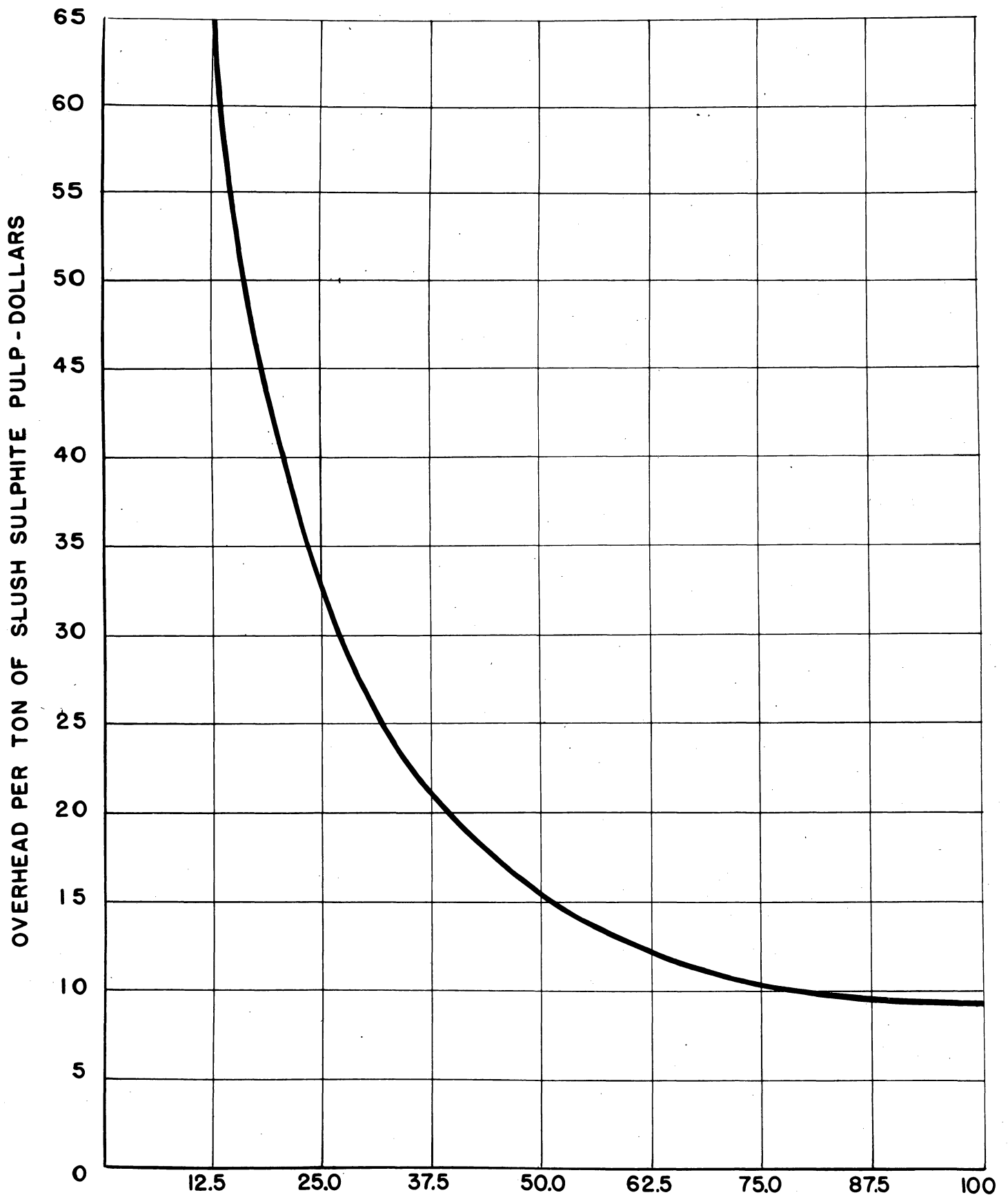
#### COSTS OF PULP PRODUCTION - SULPHITE PULP

##### Overhead Costs

The influence of overhead costs as a factor forcing production and having a strong influence on competition in the modern industry makes itself felt chiefly as it affects elasticity of supply and price-cutting. Overhead costs are of particular significance in those divisions producing low priced bulk papers where large quantities must be produced and sold if fixed charges are to be met. This chapter is, however, more concerned with analysis of the determinants of overhead costs than with marketing practices and to that end a series of "breakdown charts" are presented on the costs of sulphite pulp production.

Lack of cost data on paper production and the complexity of factors in the marketing of papers preclude the possibilities of a comprehensive analysis of that commodity. Pulp as a common unfinished good of the paper industry, however, has a marked influence on the cost of the finished product and lends itself well to cost analysis. In fact, in intra-regional competition, it is the cost of pulp, and even more important,

# CURVE OF OVERHEAD COSTS FOR A SULPHITE PULP MILL



PER CENT OF CAPACITY OPERATION

the cost of pulpwood that determines to a great extent the competitive position of the individual mill.

Because of the importance of sulphite pulp in the Northeastern industry, that grade has been selected for analysis in this paper. The initial investment in a sulphite plant newly constructed in any region is approximately 25,000 dollars per ton of daily capacity. A 100 ton mill would therefore involve an initial investment of 2,500,000 dollars exclusive of the necessary working capital or the optional investment in woodlands. Overhead or fixed charges would then amount to the following if the plant is to be depreciated over a 25 year period by the sinking fund method calculated at 4 per cent interest compounded annually:

	<u>Per Annum</u>
6% on Capital Investment .....	\$150,000
Sinking fund payments .....	60,000
Administration .....	<u>40,000</u>
Annual Fixed Charges .....	\$250,000

The relation between these fixed charges and the unit output of the plant is shown graphically in Figure 7. The importance of maintaining a satisfactory unit output is self-evident from the trend of the curve. In a period of excess capacity for the industry, due to either excess expansion or to a decline in demand for the product, individual mills, and particularly those laboring under heavy bonded indebtedness, may go to the extreme of cut-throat price cutting to maintain output at a satisfactory level and meet its fixed charges.

The paradox of the situation is that productive capacity, though always increasing in periods of general business prosperity and rising consumption, has invariably led to financial stress in certain divisions of the industry. A sudden influx of new capacity as has been characteristic of the pulp and paper industry, necessarily entails a series of new mills with high fixed charges, but comparatively low direct costs of production.

These low direct costs are due to the efficiency of the new plant and to the low wood costs which generally obtain in an area of new plant location. To keep their customers in the face of this new competition from highly efficient plants, the older mills must keep within the competitive price range or shift grades to enter other paper markets. So long as prices remain stable the older mills can operate at a profit, but unless prices are artificially fixed, additional production and the efforts of new mills to enter the markets are bound to force them down. The result of a fall in prices brings about some peculiar cost relationships as shown in Figure 8.

Theoretical Relationship of Costs in  
New Mills having High Fixed Costs  
and Old Mills with Low Fixed Costs

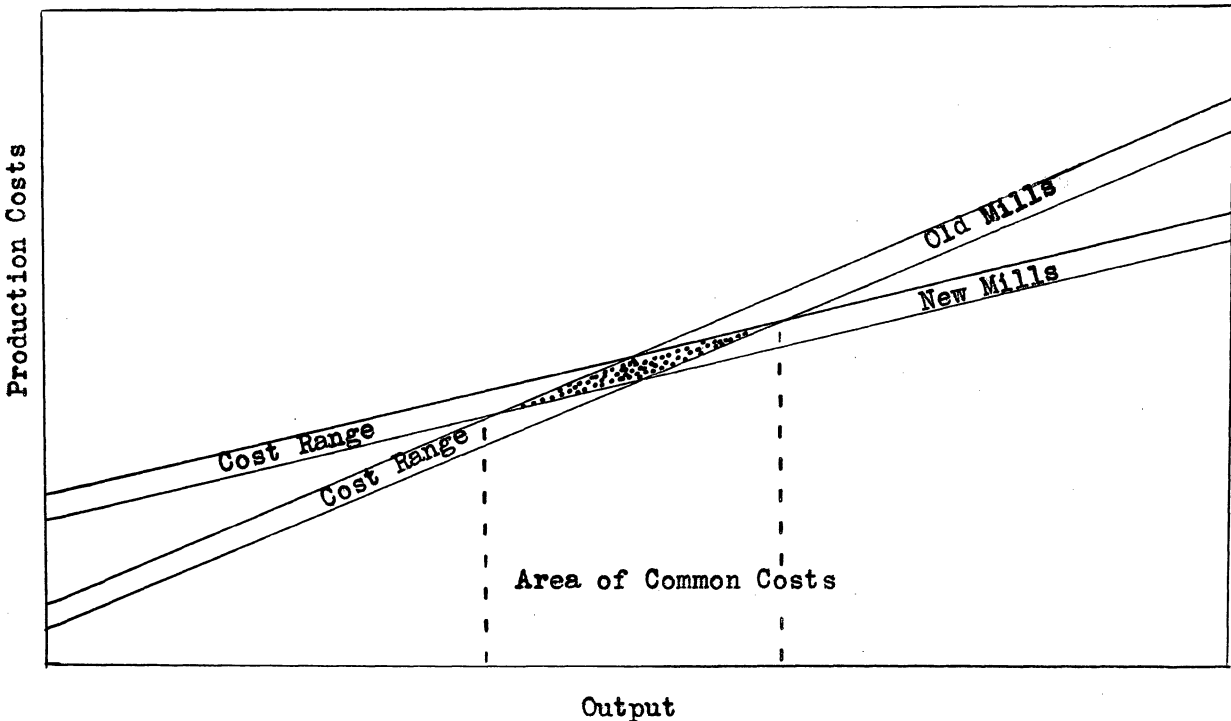


Figure 8

Line CB indicates total production costs at any unit output of the new mill, the shaded block showing the heavy block of superimposed fixed charges.

Line AD indicates the total production costs of the old mill; direct costs are high, the shaded block showing comparatively low overhead costs.

At any output below AF, lower costs obtain in the older mill than in the new mill, from F to E the reverse is true due to the wider spread over production of the heavy block of fixed charges in the new mill.

With the unit price anywhere above ED both new and old mills can operate at a profit, if the new mill operates above a capacity of F. At any price below ED old mills cease to cover production costs and their only justification for operation lies in the fact that they may place a high value on "good-will" and endeavor to keep their markets in the face of temporary financial losses. To obtain new customers, it is probable that new mills would cut prices to just cover their costs and enable them to operate above the capacity shown at F. Even with capacity below F new mills would still be justified in operating in order to meet at least part of their fixed charges.

The above discussion is, of course, theoretical; but translated into terms of dollars and cents and past experience in the industry, it has occurred many times; particularly in the bulk grades as newsprint and wrapping paper. It is this basic economic theory that lies behind the phenomenon of grade shifting, for at a price below ED, old mills must operate at a loss, shift grades, or go under.

### Depreciation

Past treatment of plant amortization in the Northeast has had a far-reaching influence on the present day competitive position of that region in the industry. Pulp and paper equipment is long-lived, and expensive. Physical depreciation is slow, but obsolescence as it applies to the use of machines on a particular grade of paper is comparatively rapid when one considers the rapid technological advances in the industry and the long period

necessary to amortize the expensive machines. Long before the machines are written-off, new plants may render them technically obsolete. Grade shifting is, of course, possible to make the equipment supra-marginal again, but whether recognized or not, physical deterioration of a plant goes on, and obsolescence reduces the value and efficiency of equipment, for in the long-run, grade shifting does not reduce the necessity for the building up of funds for replacement. The lackadaisical attitude towards the building up of depreciation reserves in the early days of the Northeastern industry has resulted in the now serious situation of many plants; for they have been "eating out of substance". A mill faced with the alternative of replacing obsolete machinery to meet new competition or of shifting grades, must choose that latter course and lose its old customers, if no depreciation reserve is available. The results in the Northeast have been felt in the successive reorganizations of many plants at lower capitalizations to balance the reduction in assets and lower earning power. The end result has been the progressive shifting of the industry to higher grades, but that a limit is reached even in that remedy is apparent in the fact that so many mills are lying idle in the region.

#### Total Production Costs

Under a hypothetical situation in which three newly built sulphite mills enter upon production in the Northeast, the Lake States, and the Pacific Northwest, Figure 9 shows the trend of total unit production costs. The picture is not entirely true since the costs used are those presented by the United States Tariff Commission in their study. The costs given by the Commission are based on operation in the regions at a single moment of time which distorts the cost picture. At any other utilization of capacity than that which applied when the study was made, unit costs for the regions would change materially. Apparently, no allowance has been made by the Commission to show such variation in unit costs with changes in total amounts



# UNIT COST OF PRODUCTION -SULPHITE PULP MILL INCLUDES DIRECT AND OVERHEAD COSTS

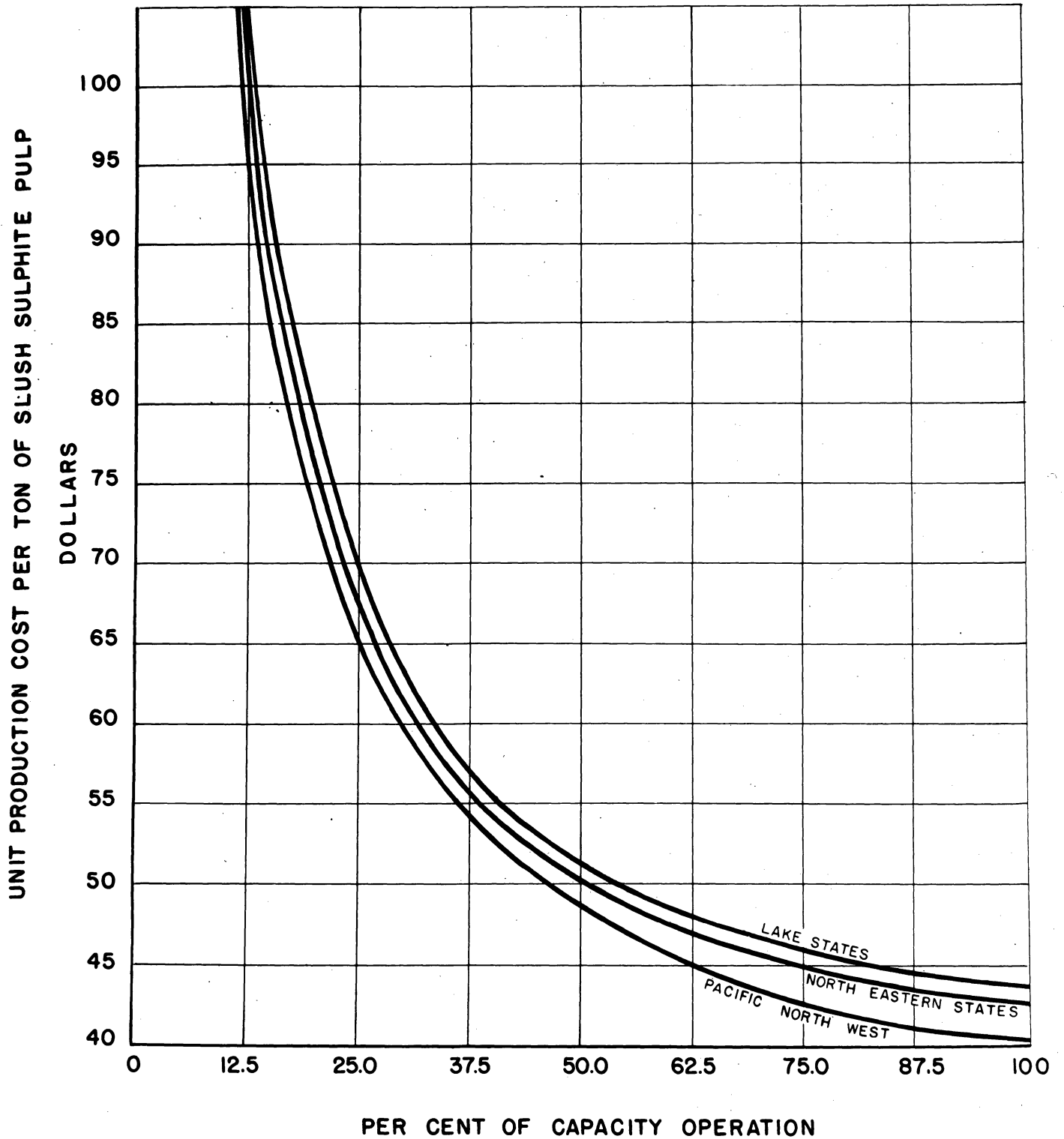


FIG 9

of production; an exceedingly important factor in any mass production industry.

Based upon the same figures of costs of pulp production (as included in the United States Tariff Commission Report), Figures 10 and 11 show a breakdown of production costs in the Northeast and Pacific Northwest respectively. The figures indicated that with sulphite pulp selling at sixty dollars per ton, bleached, lapped, and delivered in eastern seaboard markets, Northeastern mills must operate at 67 per cent of capacity and Pacific Northwest Mills at only 48 per cent of capacity to break even. As will be seen, the cost advantage of the Western mill lies almost entirely in the low wood cost in that region, and explains the fact that western pulps can be sold in eastern markets despite the high transportation charges. Pacific Northwest mills cannot, however, compete in these same markets in the paper field since wood costs become a relatively smaller item as other direct costs and transportation charges on the finished product increase.

It is obvious from Figure 10, however, that any reduction in wood costs in the Northeast would result in a considerable lowering of both total production costs and the break-even point since wood costs make up the lion's share of the total. The possibilities of lowering wood costs can, of course, only come about through growing wood in the region -- a point discussed in a later section.

## PAPER PRODUCTION

### Distribution of Capacity

As is true also of pulp production, the Northeast is also the most important paper producing region of the country. Up to 1890 the Northeast produced practically all of the nation's paper needs, but after that year the industry spread to the Lake States. Up to the 1920's these two regions produced the bulk of the domestic paper supply. After

# BREAKDOWN OF COSTS OF A HYPOTHETICAL NORTHEASTERN SULPHITE PULP MILL PRODUCING BLEACHED AND LAPPED SULPHITE PULP WITHIN THE REGION

TRANSPORTATION COST - \$4.00 PER TON

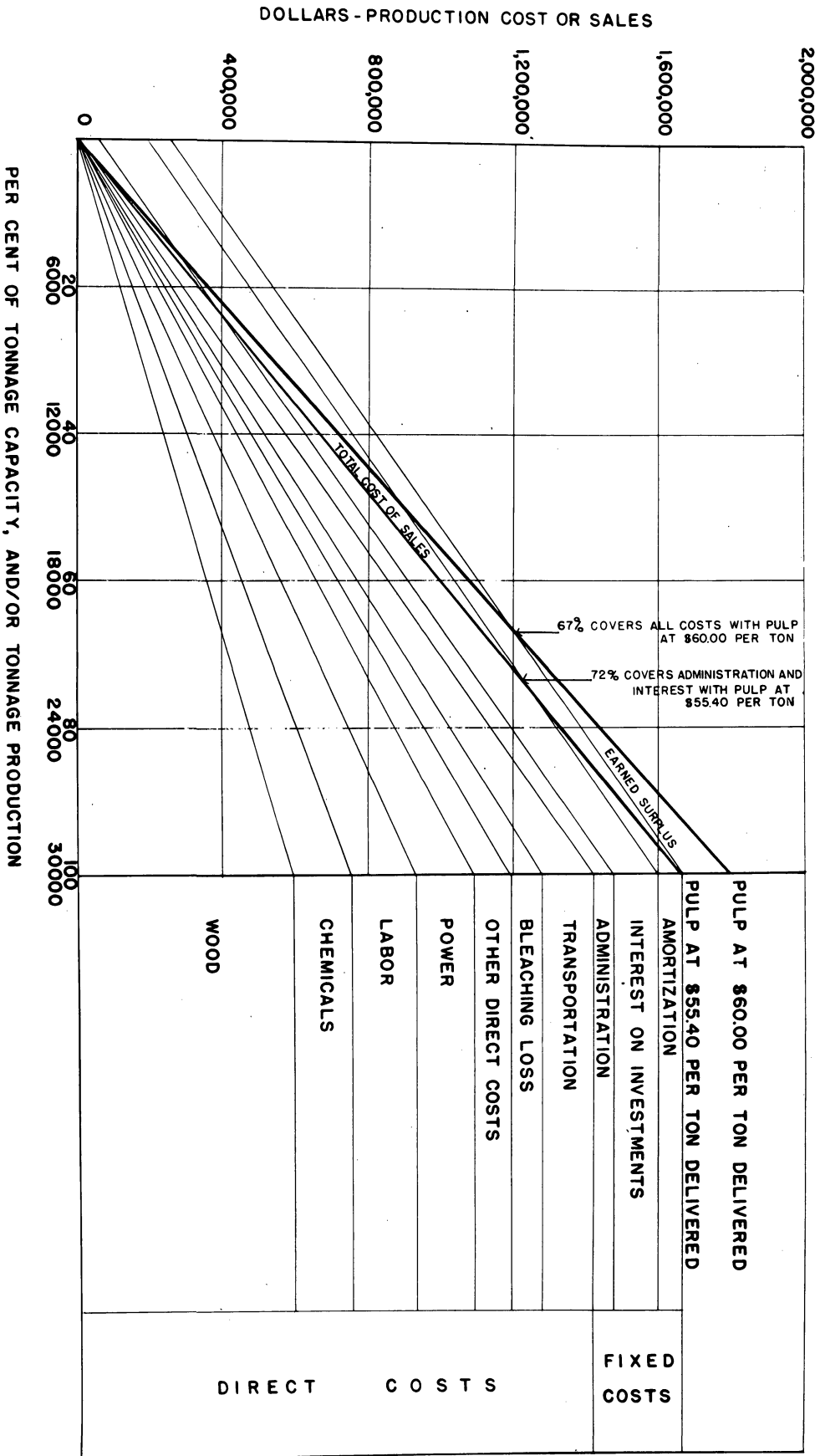


FIG 10

# BREAKDOWN OF COSTS OF A HYPOTHETICAL PACIFIC NORTHWEST SULPHITE PULP MILL PRODUCING BLEACHED AND LAPPED SULPHITE PULP FOR SHIPMENT TO ATLANTIC SEABOARD MARKETS

TRANSPORTATION COST - \$9.50 PER TON

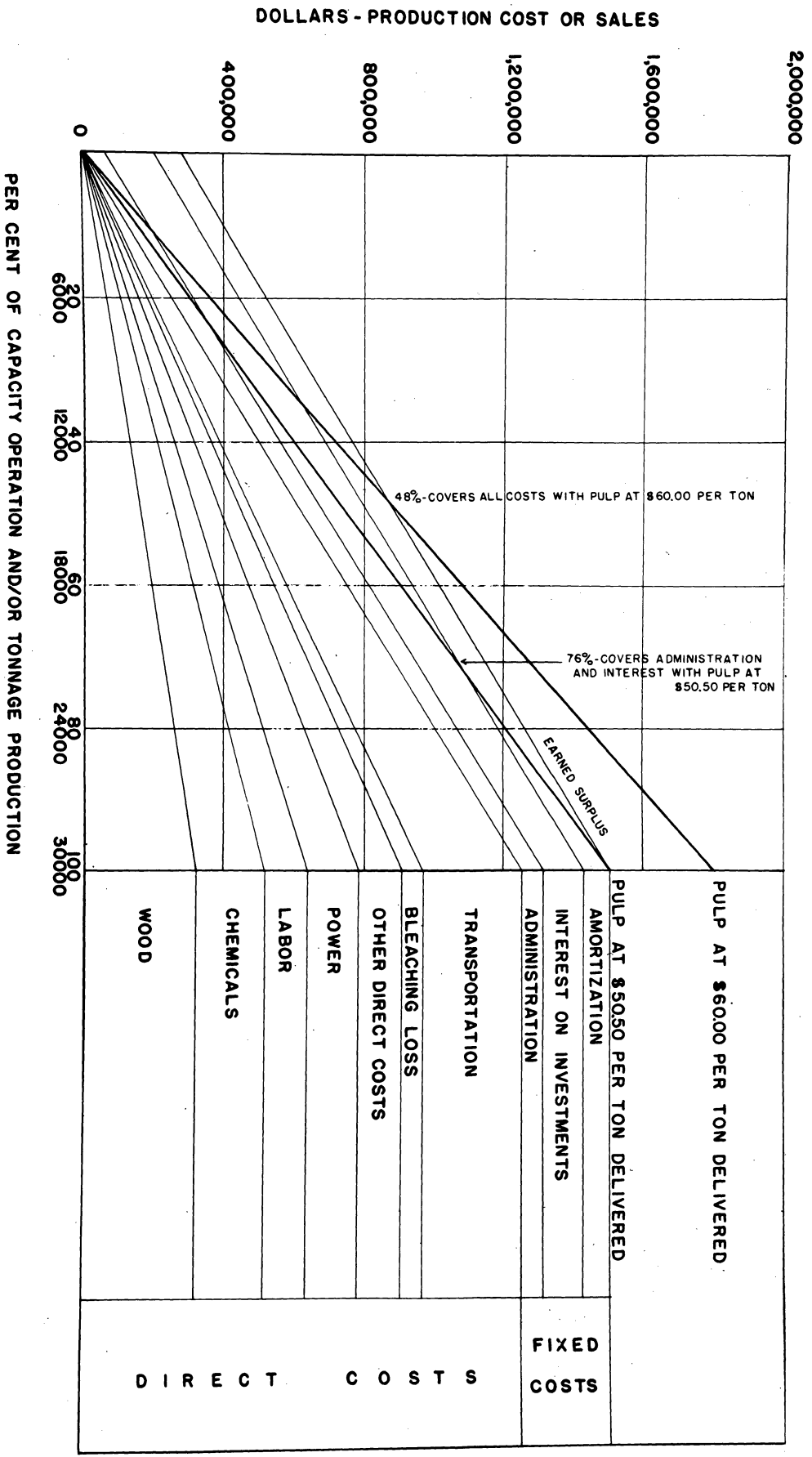


FIG II

the inception of the free tariff on newsprint in 1913, paper manufacture in Canada expanded phenomenally as has been brought out previously in this paper. After the War, pulp imports from Europe began to compete severely with domestic production, but little paper (except for certain specialized grades as cigarette paper) has ever entered the United States from that source. In the late 1920's the great expansion of the industry took place in the South and Pacific Northwest, with the result that the Northeast now produces a much smaller proportion of the domestic output than formerly.

### Newsprint

In this division Canada has largely replaced the United States as a producer as shown in Table I. Mr. R. S. Kellogg, Secretary of the News Print Service Bureau, states that there is probably no other case on record where the product of one country entered into the markets of another country to the extent that newsprint has, in so short a period of time.

Mr. Kellogg holds that the newsprint market is a fine example of a free market--despite the price leadership practices which have been so extensive in this division. He cites as proof the wide fluctuations in price which have resulted from the changing supply-demand schedule. Figure 12 shows the comparison between Newsprint and other commodity prices from 1914 to 1935 and proves the truth of Mr. Kellogg's statement.

Comparison of Newsprint  
and Commodity Prices

Bradstreet Index

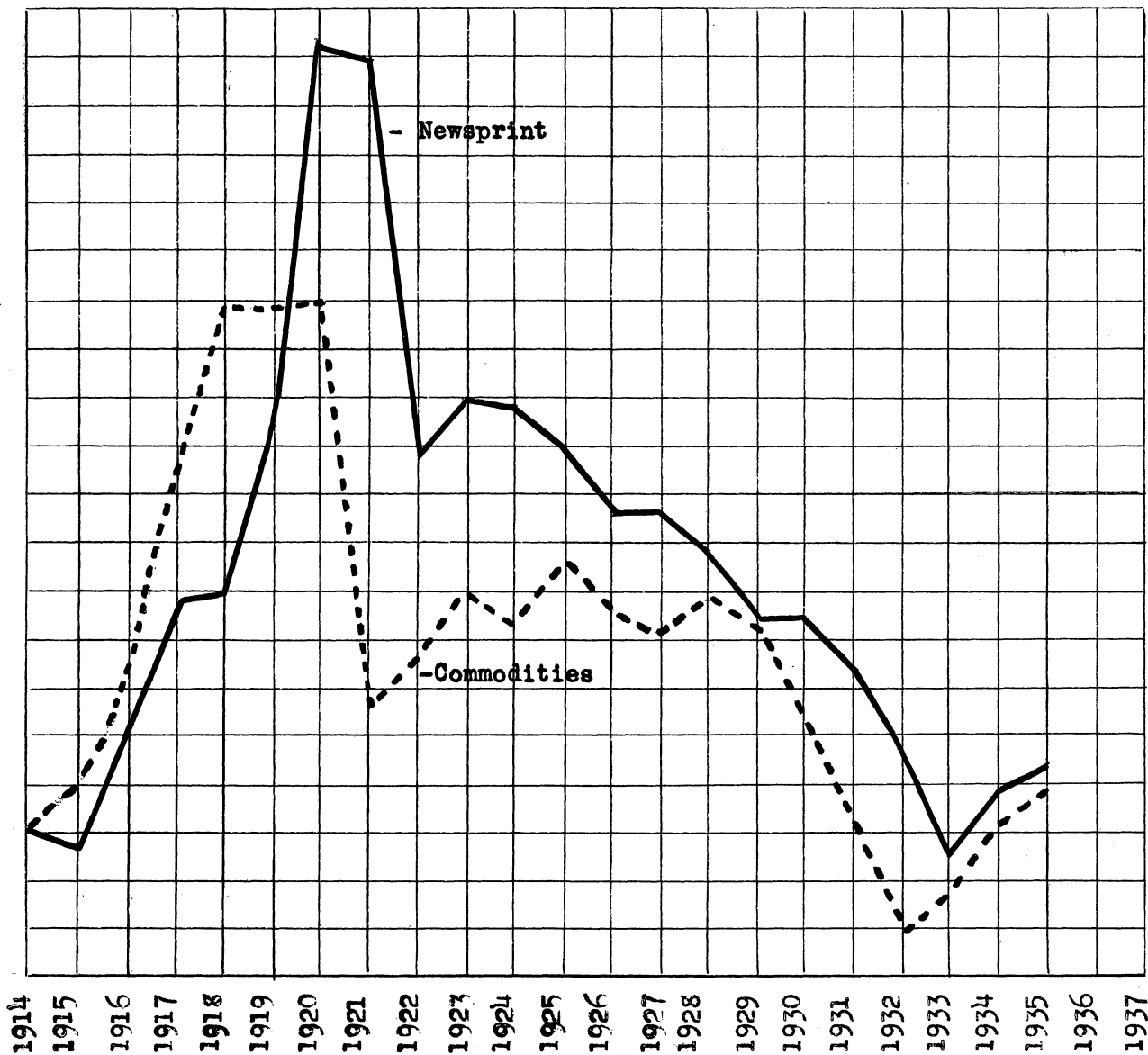


Figure 12

So far as domestic production is concerned, the chief production center of newsprint is in the Northeast. Annual capacity of the national newsprint industry in 1936 stood at about 1,000,000 tons, of which Maine has 39 per cent, New York 17 per cent, and Washington 13 per cent. (26)

### Wrapping and Bag Paper

The South is now the dominant region in this division. Virginia, Alabama, Louisiana, and Arkansas produced about 63 per cent of the domestic needs in 1936. (26)

### Paperboard

Six states, Michigan, Illinois, New York, New Jersey, Ohio, and Indiana have 67 per cent of the national production capacity in this division. Plants are located close to centers of waste paper supply -- the chief material for paperboard manufacture. (26)

### Book and Writing Papers

The relative distribution of productive capacity in this division is best shown by the fact that over 70 per cent of the capacity lies within overnight travel distance of New York City. (26) Of the Northeastern States, Massachusetts and New York are the chief producers.

### Tissue and Crepe Papers

More than 90 per cent of the productive capacity of this division lies within 500 miles from New York City and Milwaukee. New York and Wisconsin together have 27 and 28 per cent respectively of the national capacity. (26)

### Miscellaneous and Specialty Papers

The productive capacity of this division makes up about one-third of the total capacity of the industry. Plants are concentrated in the Northeast, the Central States, and the Lake States, with little or no capacity apparent in any other region.

Competitive Position of the Northeast  
in Present Paper Markets

Paper may be broadly classified into two groups, cultural and mechanical, for purposes of marketing studies. Cultural papers are those which are exacting in their requirements, demanding specific features depending upon the use to which the paper is to be put. They are made chiefly from sulphite pulp, in admixture with soda pulp for book papers, with rag stock for certain high grade papers, and with groundwood for some lower grade cultural papers. Mechanical papers, on the other hand, are those used for mechanical purposes. They are, on the whole, not exacting in their requirements, strength being their chief feature. The mechanical papers are made chiefly from sulphate pulp, but waste paper, groundwood, and sulphite pulps are used to varying degrees. While many other materials such as jute, hemp, and straw are also used in the manufacture of mechanical papers, wood remains the dominant basic material -- and with the rapid rise of the southern kraft industry is, in fact, replacing most other materials.

Many enthusiastic individuals, if one is to believe the literature of the day, seem convinced that it is only a matter of time before the important eastern and mid-western markets will be almost wholly supplied with cultural as well as mechanical papers by the southern industry. The reasoning of these individuals is invariably based on low wood costs which now obtain in the South. It is true that the South has almost completely taken over the mechanical paper markets and will continue to dominate these expanding markets. So far as the Northeastern industry is concerned, the markets for certain mechanical papers, notably wrapping and bag papers, were lost through lack of raw materials rather than the lower cost of materials in the South. Even under intensive forestry practices, wood supplies in the Northeast would be far from sufficient to meet the demands of the Northeastern mechanical paper markets.



The regional shift was inevitable, nor was it undesirable for it has tended towards a more balanced utilization of our forests.

In the division of cultural papers the picture is a vastly different one. The determining factors in the respective competitive position of the regions lie deeper than pulpwood supplies and pulpwood costs. Technical and economic items will probably determine where the equilibrium of competition between the regions will rest.

It cannot be said that any successful commercial operation in cultural paper-making has yet been achieved in the South. While many of the laboratory experiments on the manufacture of newsprint and writing papers from Southern pines seemed satisfactory, commercial operation has shown a different picture. Difficulties in bleaching the dark southern kraft and prospective sulphite pulps increase the cost of producing cultural papers from them to a point where costs become excessive. The multi-stage bleaching required to whiten these pulps also results in a product inferior to that made from spruce, balsam, and hemlock.

Of even greater importance than the technical factors involved in regional competition (for these may be overcome in time) are the economic items of plant location and marketing. The item of plant location is a tangible one and can be dealt with somewhat more specifically than the problem of marketing. As was pointed out previously, 70 per cent of the book and writing paper capacity lies within overnight travel of New York City; more than 90 per cent of the tissue and crepe paper capacity lies within 500 miles of New York City and Milwaukee, and the miscellaneous and specialty papers mills are closely concentrated around the large centers of consumption in the Northeast. In addition, the paperboard mills using large quantities of waste paper are nearly all located near New York City, Albany, Boston, and other centers of waste paper supplies. Wood costs in these stated grades are a minor

item -- the great proportion of costs being in direct labor and selling expense. Low wood costs of other regions have little bearing in competition in these markets. The proximity to markets is another great advantage to the Northeastern industry; and with the advent of truck transportation, the region has gained an even stronger competitive position. A large proportion of the cultural papers are sold through wholesalers and in less than carload lots. In such sales fields, truck delivery is cheaper, faster, and cleaner than rail. Packaging requirements are more flexible and less exacting by truck than by rail shipment and door-to-door delivery of the former makes for convenience of both buyer and seller. Unfortunately, comparative transportation rates of rail and truck are not available, but the advantages of the Northeastern industry over the South in these items is obvious.

The question of marketing and "good-will" is less tangible, but equally important. The Northeast, as the oldest domestic paper producing region, has over a long period of years gained definite selling advantages over the other regions. Control of markets depends not only on costs, but also to a great extent on good-will which mills have built up in their previous dealings with customers.

Some divergence from the topic is necessary to explain this point. Once a plant is installed, the cost of operation depends to a large degree upon the success of the selling force in marketing enough goods to utilize the equipment adequately. Where goods are made only to order, production depends upon sales in a more immediate and imperative way than where they are made to stock. On the other hand when unsold goods are piling up there comes a point where production depends on moving the stock out of the warehouse. They have in a sense become an overhead cost and pressure may force them to be sold below cost. In the early years of the Northeastern paper industry, production was chiefly in the bulk grades and intensive sales effort

was unnecessary except in periods when unsold goods were piling up. This was particularly true since little regional competition was in effect. The nucleus of a sales organization was, however, started early. As production of the bulk grades have been progressively replaced by other producing regions, the Northeastern industry has steadily shifted to production of cultural papers. This progressive movement necessitated the building up of even stronger sales forces -- as is evident in the Northeastern industry today. The trend is not new, it has been in effect for about fifteen years and will no doubt continue.

One might question what effect these trends have had on regional competitive positions. The answer is simply that intensive sales effort is necessary to sell the higher grades of paper and the Northeast has come by a good deal of experience in this line. Sales effort is often regarded as a long-time investment in "good-will". Sales made today do not stand alone; if they mean satisfied customers they mean future sales. If this "good-will" were a tangible asset, it would be charged on the books at cost, and depreciation charged upon it; depending on its probable term of life. Obsolescence of "good-will" is more insidious and far more uncertain than that of a machine. This "good-will" of the Northeastern industry in the cultural papers division has not depreciated; rather it has been continually strengthened, and stands today as <sup>an</sup> intangible, but invaluable asset. Special demands of publishers, though often regarded as technically impossible at the time, have been constantly met by the Northeastern industry. Such instances are conspicuous in the older regions and have greatly strengthened the ties between buyer and seller.

The problem of regional competition then resolves itself that unless other regions can meet the quality production of the Northeastern industry and at the same time drastically undercut prices, present and potential cultural paper markets will remain in the hands of the Northeastern industry. Specifically, it is becoming increasingly evident that the South cannot produce cultural papers on a favorable competitive basis with the Northeast. The Pacific Northwest, even with its extremely low material and production costs, is precluded from competition in eastern paper markets by distance and excessive transportation rates. In effect, the high transportation costs on paper from other regions to the eastern markets, form a natural protective tariff for the Northeastern industry.

#### POSSIBILITIES OF PULPWOOD FORESTRY IN THE NORTHEAST

##### General Discussion of the Problem

The fact that many Northeastern paper mills have shut down their digesters due to high wood costs and become converting plants; while other mills reach farther and farther for their wood supplies indicates that the ruining stage of Northeastern wood resources has long passed. In the case of mills which buy their wood from outside sources, it is certain that many of them could materially reduce their costs in the long-run by building up forest units close to the mills. Mills which now own their woodlands and either maintain a woods operation department or contract out the woods operations, may find it advantageous to practice silviculture in conjunction with logging and apply scientific minimum cost studies in an effort to reduce wood costs. Certainly, from a long-run viewpoint, if Northeastern mills are to continue to operate on a favorable competitive cost basis in many divisions of the industry with both domestic producers of other regions, and

foreign producers, it is certain that future pulpwood supplies must come from fixed and reasonable distances within the region.

Under present conditions, the Northeast must become increasingly dependent upon wood pulp imports from other sources. As paper consumption in foreign countries increases, as it surely will, and cellulose materials become important for other purposes, the future may see foreign wood pulp supplies to the Northeast curtailed and high in price. As these worldwide adjustments take place, the Northeastern industry might do more than save their present holdings as a backlog. The stand per acre can be materially increased, the better areas built up, and the poorer areas sold or allowed to revert to public ownership.

In the face of these changing worldwide trends the recent statement by the Tariff Commission in its report has no economic or social merit. The statement says, "It is not clear that holdings of timberlands are necessary to the successful operation of a pulp mill, unless the lands are considered an insurance against abnormally high prices of wood from other sources". (36) Would the Tariff Commission keep its money in a bank at 2 per cent interest when sound investments are available paying 6 per cent? If the lands are to be held as a backlog, would it not be wise to increase their productivity against the time when pulpwood and wood pulp prices in the Northeast will become excessively high. In view of a worldwide expanding economy, it seems a defeatist attitude to disallow the probabilities of future increased prices of supplies from other sources. It would mean that our economic order has become static, and that the present full utilization of European forests will not be diverted to home use. In the United States, present pulpwood prices of the South and Pacific Northwest do not cover the costs of growing the wood and as paper consumption increases and new uses are found for cellulose, wood prices must rise as economically located forests are exhausted.

So far as the Northeast is concerned, the present day attitude on the part of many individuals, both inside and outside the ranks of foresters, seems to be that the region is a "has been" in the field of industrial forestry. There is, no doubt, some truth in that attitude as it applies to the lumber industry in the Northeast, but the possibilities of pulpwood production in the region seem good indeed. In combination with pulpwood growth, hardwoods may prove profitable either for lumber or as a future source of cellulose.

No other forest region in the country can show the remarkable recuperative powers of the soil or the low fire hazard of Northeastern forests. To offset the moderate rates of growth, there exist the excellent transportation facilities, the proximity to markets, the valuable tree species, the ability of the soil to restock fully and naturally, and the equitable systems of forest taxation -- all of which combine to make forestry an attractive proposition. The individual pulp and paper mill executive who gazes upon a fifty year old stand in the Northeast which carries but five to ten cords of spruce per acre is justifiably dubious about the wisdom of investing money in such lands. His skepticism may be further heightened by wild tales of "cord per acre per year growth" in other regions. Whatever the case in other regions may actually be, Northeastern forest lands of the moderate and better site classes can undoubtedly compete on a value-growth basis in pulpwood forestry. Particularly is this true with the inevitable regional economic adjustment taking place in land values. As new forest regions become important sources of supply for the pulp and paper industry, a revaluation of forest lands in both the new and old regions is in order. As was stated previously, present pulpwood costs in the newly opened regions are less than the cost of growing -- a condition which cannot persist for prices in the long-run must be equated by costs. Within the comparatively short space of time (perhaps one or two decades) that it will take the

industry to pass through its present transitional period and reach a regional equilibrium, forest lands in all regions will, no doubt, take on true values.

In any business venture, costs must be incurred to realize an income. Forestry is no exception and the fact that during the initial "building-up" period of a forest, the returns may be deferred, makes the eventual profit no less certain. The following pages deal briefly with regional wood requirements, yields, costs, and financial returns of forestry. Each mill involves its own pulpwood and forestry problem -- the figures presented here apply broadly only, and variations in the individual case are highly probable. They do, however, present what appears to be the maximum in costs combined with rather conservative figures of growth and yield.

Pulpwood Requirements of the Northeast

Based upon a full utilization of 1936 pulp mill capacity, the pulp industry in the Northeast would require an annual wood supply as shown in Table VII:

TABLE VII: PULPWOOD NEEDS OF THE NORTHEASTERN WOOD PULP INDUSTRY BASED UPON 1936 CAPACITY AS COM-  
FILED FROM LOCKWOOD'S DIRECTORY OF THE PAPER  
AND ALLIED TRADES

(Quantities in Thousands of Cords)

<u>State</u>	<u>Groundwood</u>	<u>Sulphite</u>	<u>Sulphate</u>	<u>Soda</u>	<u>Total Requirement for State</u>
Maine	679	775	83	248	1,785
New Hampshire	56	550	-	-	606
Vermont	60	-	-	-	60
Massachusetts	15	30	-	15	60
New York	613	450	-	173	1,236
Pennsylvania	-	250	-	250	500
Total	<u>1,423</u>	<u>2,055</u>	<u>83</u>	<u>686</u>	<u>4,247</u>

Broken down by species, the needs of the Northeastern industry are about as shown in Table VIII. It is difficult, or impossible to show any clear-cut lines between the species of wood required and those actually used, for technological developments are constantly widening the range of woods suitable for pulping by the various chemical processes. It has been said by executives of foresight that twenty or thirty years hence, almost any wood will be used for paper-making -- a possible fact that at the same time complicates the preparation of forest management plans but amplifies the problem of pulpwood forestry in the Northeast.

TABLE VIII: FULL CAPACITY PULPWOOD NEEDS OF THE NORTHEASTERN PULP INDUSTRY BY KINDS OF WOOD -- (BASED UPON 1936 CAPACITY AS COMPILED FROM LOCKWOOD'S DIRECTORY OF THE PAPER AND ALLIED TRADES

(Quantities in Thousands of Cords)

<u>State</u>	<u>Spruce and Balsam</u>	<u>Hemlock</u>	<u>Pine</u>	<u>Hardwoods</u>
Maine	1,450	?	83	248
New Hampshire	606	?	-	?
Vermont	60	?	?	?
Massachusetts	60	?	?	15
New York	1,063	?	?	173
Pennsylvania	<u>250</u>	<u>?</u>	<u>?</u>	<u>250</u>
Total	<u>2,489</u>	<u>?</u>	<u>83</u>	<u>786</u>

The quantities shown in Figures 7 and 8 are, of course, a gross overstatement of the quantities actually used in the Northeast in past years. Actual pulpwood consumption of the region for 1936 as compiled by the Bureau of Census stood:

Maine .....	1,176,636 cords
New Hampshire .....	Unknown
Vermont .....	14,385 cords
Massachusetts .....	Unknown
New York .....	574,937 cords
Pennsylvania .....	<u>303,828 cords</u>
Total	<u>2,069,786 cords</u>



Including New Hampshire and Massachusetts, pulpwood consumption for the region in 1936 ran around 2,500,000 cords, a figure considerably less than pulping capacity. The reasons for under-utilization of capacity lie entirely in the high pulpwood costs -- the greatest single item in these costs being transportation charges.

Sources of Supply

The pulpwood requirements of the Northeast are mainly met from sources within the region, but a considerable amount of wood is imported from the provinces. Actual sources of pulpwood used by the Northeastern industry in 1936 are shown by states in Table IX:

TABLE IX: SOURCES OF PULPWOOD USED BY NORTHEASTERN PULP MILLS BY PERCENTAGE FROM EACH SOURCE.  
1936

Source: American Paper and Pulp Association

State where Used	Source							
	Maine	N.H.,Vt., Mass.	N.Y.	Penn.	Ont.	Que.	N.B.	N.S.
Maine	56 %	1 %	-	-	-	-	28 %	15 %
N.H.,Vt.,Mass.	8	89	-	-	-	3 %	-	-
New York	6.5	-	40 %	-	5.5 %	41	7	-
Pennsylvania	(Not available)							

Examination of Table IX shows that over 40 per cent of the needs of the two chief pulpwood using states of the Northeast are met from Canadian sources. When one considers that imports of these supplies are subject to the pleasure of the Provincial Government, the situation assumes a serious aspect. Only a minor quantity of pulpwood moves from state to state, but state lines are of little economic significance in the movement of forest products. In general, the mills closest to regional pulpwood supplies, no matter how geographically located, will control those supplies (on uniform terms of transportation and ownership).

### Present Pulpwood Resources

The only public source of information concerning the present area and quantity of timber in the Northeast is to be found in the Copeland Report (A National Plan for American Forestry). It is unfortunate that no comprehensive forest survey, such as has been carried out in the South, the Lake States, and the Pacific Northwest, is available for the northeast. The available information on forest stands in the region is, at best, only a guess, and in the absence of information on the geographic location of the forest areas and volumes per acre, an analysis of the region's pulpwood resources has little meaning. Information on total quantities of timber is useless for the true value of the forest is not so much quantity as availability.

The Copeland Report shows the total forest land (i.e. land suitable only for tree growth) in the Northeast is 54 million acres of a total land area of 105 million acres. Of this area, 13,860,000 acres are listed as "saw-timber" areas, 4,843,000 acres are listed as "cordwood" areas, 6,145,000 acres as "fair-to-restocking", and 2,425,000 acres as "poor and non-restocking". The reason for the large area shown as "saw-timber" is that the major part of the spruce-hardwood forests of the Northeast have been repeatedly culled for spruce and are now essentially unbroken hardwood sawtimber areas. Poor form of the hardwoods make most of these stands of very low value and results in a rather unfavorable situation as based upon present utilization practices.

Total timber volumes as shown to exist on the forest lands of the Northeast are still formidable. Table X indicates the total volume of present pulping species given in the Copeland Report.

TABLE X: STAND OF PRINCIPAL KINDS OF WOOD NOW USED IN PULP AND PAPER MANUFACTURE IN THE NORTHEAST

<u>Kind of Wood</u>	<u>Total</u>	<u>(Quantities in Thousands of Cords)</u>	
		<u>New England</u>	<u>Middle Atlantic</u>
<b>Softwoods:</b>			
Spruce and Fir	50,961	45,030	5,931
Hemlock	19,567	10,467	9,100
Pine	<u>38,765</u>	<u>24,190</u>	<u>14,575</u>
Total	<u>109,293</u>	<u>79,687</u>	<u>29,606</u>
<b>Hardwoods:</b>			
Cottonwood and Aspen	12,342	10,590	1,752
Yellow Poplar	3,490	152	3,338
Beech, Birch, Maple	183,816	115,235	68,581
Gum	<u>2,601</u>	-	<u>2,601</u>
Total	<u>202,249</u>	<u>125,977</u>	<u>76,272</u>
<b>Total, All Species</b>	<u><u>311,542</u></u>	<u><u>205,664</u></u>	<u><u>105,878</u></u>

The bulk of the Northeastern pulpwood species are located in New England, that group of states having about two-thirds of the total volume.

Slightly over twenty per cent of the pulpwood located in New England is spruce; 70 per cent of which is in Maine.<sup>(35)</sup> About one quarter of Maine is listed as inaccessible.

The Middle Atlantic States have only twenty per cent of the total volume of spruce in the Northeast, accounting to a great extent for the large imports of pulpwood into New York as shown in Table IX. The high price of spruce stumpage in the Middle Atlantic States have made it profitable to cut stands averaging only two cords per acre.

Hardwood stands make up about two-thirds of the total pulpwood supply in the region. In contrast to a large proportion of the spruce stands, most hardwood areas are easily accessible. The potential value of hardwoods for wood pulp cannot be underestimated. One or two pulp and paper companies in the region have undertaken an extensive program of hardwood utilization with a fair measure of success. (See Appendix C).

Duration of Present Pulpwood Supplies

Estimates as to how long these present pulpwood supplies will last have been made by various foresters. Forrest H. Colby in the February, 1938, Journal of Forestry gives an estimate as shown in Table XI for softwoods in New England:

TABLE XI: AVAILABLE VOLUME OF SOFTWOODS IN  
NEW ENGLAND AND NUMBER OF YEARS  
SUPPLY

<u>State</u>	<u>Available Volume in Cords</u>	<u>Annual Consump- tion in Cords</u>	<u>Supply for Number of Years</u>
Maine	45,000,000	1,100,000	41
New Hampshire	9,000,000	320,000	28
Vermont	6,000,000	115,000	52
Massachusetts	<u>800,000</u>	<u>100,000</u>	<u>8</u>
Total	<u>60,800,000</u>	<u>1,635,000</u>	Average <u>37 years</u>

With all due respects to Mr. Colby as an able prophet, his figures are of no value. Where are the stands located; what technological changes in pulpwood utilization will take place; what will be the future Canadian policy on pulpwood exports? These and other pertinent questions must be answered before any clear analysis of the situation can be undertaken. In the absence of adequate information on location and growth of Northeastern forests, an answer becomes not only far-fetched, but impossible.

Forest Types in the Northeast

The Northeast may be broadly divided into four forest regions. These are as follows:

- The Spruce-Fir Region
- Northern Hardwoods
- White Pine
- Sprout Hardwoods

So far as the pulp industry is concerned, the Spruce-Fir Region and the Northern Hardwoods Region are two of chief importance. The accompanying maps show the extent of these areas.

The forests of the Spruce region can be advantageously divided into six types, each showing certain peculiarities of composition and growth, but oftentimes grading into one another imperceptibly. Of these six types, two are transitory in nature, owing their existence to fire or some other catastrophic event. The four remaining types are permanent and form the so-called climax forests of the Northeastern Spruce region. The six types are:

Permanent

1. Spruce Swamp
2. Spruce Flat
3. Spruce Slope
4. Hardwood

Temporary

5. Birch and Poplar
6. Old Field

1. Spruce Swamp:

Forests of the swamp type occur on low poorly drained areas. They are most abundant in Maine and comparatively rare in the hilly and mountainous country which typifies most of the other Northeastern States. Such areas, on the whole, are characterized by slow growth and dense stands of black spruce and fir with an admixture of poorly formed hardwoods. Site index runs from 30 to 40 and as pointed out in a further chapter, are apt to prove a poor investment from a forest management standpoint.

2. Spruce Flat:

This type occurs on low rolling ground. It is an abundant type on the moist level areas of Northern New York, Maine, New Hampshire and Vermont. Permitted to grow naturally, the normal composition runs to about fifty per cent red spruce, black spruce being entirely absent. Balsam fir may make up an additional twenty to thirty per cent of the stand with hemlock, white pine, and hardwoods forming the minor species.

Spruce and balsam reproduction is plentiful in this type, and except where severe fires occur, natural reproduction may be depended upon to yield full restocking of the area. Site index may run from 40 to 60 with the average at 50. This type, where it occurs in satisfactory units is undoubtedly a sound investment for growing pulpwood.

### 3. Spruce Slope:

This type occupies the steep rocky slopes throughout the mountainous parts of New England and New York. While the soil is thin and well drained, the spruce-fir yield from such areas is both high in quality and quantity. Spruce and fir make up from 70 to 90 per cent of this type, and with a minor amount of silvicultural practice, pine stands of these species may be obtained.

Site index runs from 50 to 70, exceptional areas showing stands of 50 cords per acre at fifty years.

### 4. Hardwood Type:

This type is predominant on the lower slopes of the mountainous areas of Central and Southern New England, New York, and Pennsylvania as well as the broad rolling valleys of these states. While predominantly birch and maple, red and white spruce may make up twenty to thirty per cent of such stands.

Profitable management of such areas must be on an integrated basis. Intensive silvicultural operations may alter the representation of species to yield up to fifty per cent spruce. Hardwoods, however, are an ever present problem in such stands and it is neither financially feasible nor silviculturally desirable to wholly eliminate them. Where present pulp and paper company holding contains a fair representation of this type, integrated management is entirely possible. Hardwoods may be utilized for lumber, cellulose, or pulp depending on the individual industrial set-up.

5 and 6. The Temporary Types:

Experience has shown that except where such types are intermingled with satisfactory management units owned by pulp companies, they should be eliminated. Management of such areas is likely to prove a costly investment and one that should fall to the public rather than to private enterprise. It is impossible to show satisfactory financial returns when planting costs of 12 to 15 dollars per acre must be incurred as in these types.

The Northern Hardwoods Region:

This region is a transition belt averaging about twenty miles in width and extending across the Northeast between the Spruce-Fir Region to the North and White Pine Region to the South. Its presence is explained by the underlying bed of limestone which makes the site extremely favorable to hardwood growth. So far as Spruce and Fir are concerned the region is of little importance; these species occurring only as a small percentage representation of the Stands.

White Pine and Sprout Hardwoods Regions:

These regions will not be dealt with here. Though they may eventually prove of great importance to the paper industry, their present management is precluded by the high financial costs involved in satisfactory management.

COSTS AND RETURNS OF PULPWOOD FORESTRY  
IN THE SPRUCE-FIR REGION

General Discussion

In analyzing the costs and returns of intensive forestry, it is impossible to avoid making certain basic cost assumptions. Plans for future operation must necessarily rest upon a base of present cost levels or some past average. The fact that costs in the future will fluctuate to an unpredictable degree does not, however, eliminate the

need of charting the course for the future -- that is, laying down a definite policy and plan. A well developed and flexible plan of forest management, if followed, cannot assure a definite financial return, but it does assure the highest unit productivity from the land. In that latter fact must lie the real interest of the pulp and paper industry. The time is rapidly approaching when prices of wood must cover the costs of growing that material. That part of the industry which first attains the objective of efficient land utilization will first enjoy the lowest long-run cost of its raw material. In the final analysis, the long-run costs and returns of forestry are relatively unimportant as it concerns the pulp and paper industry as a whole. A general country-wide rise or fall in wood costs must be reflected by an increased or decreased price for paper or adjusted manufacturing costs through technical advances. The factor of prime importance is assurance of a definite future wood supply.

The mill with its own perpetual wood supply located at a reasonable distance from the plant need not be a competitive bidder for its raw material and subject to the vagaries of the market, but a business certain of its raw materials at a cost predetermined within reasonable limits. In addition the mill producing its own wood can, through its own forestry and engineering force, constantly effect cost reductions in logging and transportation which cannot be shown in a management plan, but will reflect themselves in lower delivered costs of raw material.

Presented in the following paragraphs are costs and returns of forestry in the Spruce-Fir Region as based upon available figures.

#### Yields of Spruce

The most comprehensive yield tables on spruce in the Northeast are those shown in Forest Service Bulletin No. 142. Site 80 as shown in the bulletin has been omitted as being too limited in area to include in extensive calculations. The calculations which follow are all based



upon the yields as shown below:

**TABLE XII: RED SPRUCE -- VOLUME IN CORDS PER ACRE OF ALL TREES IN AND ABOVE THE 4 INCH DIAMETER CLASS**

Total Age	Merchantable Volume Only				
	Factor 95 used for Converting				
	Site Index				
	70	60	50	40	30
30	5.3	3.6	2.2	0.9	-
40	22.7	17.4	11.7	6.3	1.5
50	50.3	39.7	29.1	17.6	5.1
60	72.1	58.4	44.2	28.9	9.9
70	85.3	69.7	54.2	36.5	14.7
80	93.5	76.6	60.0	41.3	17.6
90	79.7	80.5	63.2	43.8	18.9
100	100.7	82.8	65.2	45.4	20.0

Bulletin 142

N.E.F.E.S.

Table based on 401 sample plot.

Land Values

Based on the record of purchases by the National Forest Reservation Commission, bare land values of New England forest areas vary between 3 and 5 dollars per acre, shading on the average towards the lower figure. Calculations in this report will deal with site classes 40, 50 and 60 with values of \$3 per acre for the lower two classes and \$4 per acre for Site class 60.

Whether land is already held by pulp and paper companies or whether it is purchased for forestry purposes does not discount the fact that interest should be charged against the cost value. Using the above figures as a base, the following Table shows the interest charges on the land to be borne by the timber thereon at various ages --

Interest at 4 per cent Compounded Annually:

<u>Age-Years</u>	Sites 60 and 50	Site 40
	Land @ \$4.00 per acre <u>Interest Charges \$4 (1.04<sup>n</sup>)-\$4</u>	Land @ \$3.00 per acre <u>Interest Charges \$3(1.04<sup>n</sup>)-\$3</u>
40	\$15.20	\$11.40
50	24.42	18.32
60	38.08	28.56
70	58.28	43.71
80	88.20	66.15

Taxation

The great lack of uniformity between the forest tax laws of the individual Northeastern States makes it rather difficult to assign an average per acre tax for the region as a whole. However, with forest land in the region yielding a fair return of pulpwood, it is certain that taxation forms a smaller burden to the landowner than does the carrying charge on the property. The fact that taxes are payable in cash at definite intervals while interest charges on the land investment appear only on the books, makes that latter item no less certain and burdensome.

A summation of the forest tax laws of several of the Northeastern states follows:

Maine:

All unorganized townships are placed in a forestry district covering 10,000,000 acres. This area is subject to a tax of  $2\frac{1}{4}$  mills on assessed valuation.

Forest plantations are exempted from taxation for 20 years if there are at least 640 well distributed trees per acre and trees are kept in good condition.

Massachusetts:

Annual tax on land only plus yield tax on cut.

**New Hampshire:**

Land planted with not less than 700 trees per acre may receive the following rebate: first ten years, 90% of taxes assessed on land; second ten years, 80% of taxes assessed on land; third ten years, 50% of taxes assessed on land. Thereafter full tax on assessed value.

**New York:**

The Fisher Law of 1927 states that lands reforested since January 1, 1921 are taxed annually at the value of bare land with 6% of the mature stumpage value to be paid at time of cutting.

**Vermont:**

Plantations exempt up to 30 years after planting. Land tax payable annually plus yield tax on final cut.

**Pennsylvania:**

Lands used exclusively for forests may be assessed at not more than \$1 per acre with yield tax due at time of final cut.

On the whole it appears that the forest tax laws of the Northeastern States are far from inequitable if applied to producing lands.

A hypothetical timber tax is set up in the following table which is representative of Northeastern forest tax laws. The assumptions are that land is exempt from taxes if planted to trees. A value of \$2 per cord is assigned to stumpage as a basis for assessment but property is exempt from taxes for the first twenty years of the rotation. First assessment is made at the end of the 20th year and reassessments at ten year intervals. Stumpage shows no value in the 20th year but a lease tax of 10 cents per acre per year is levied for that period.

Interest at 4 per cent compounded annually and general property tax is set at 1 per cent.

Forest Plantation Taxes  
Site Index 60 (Per Acre)

<u>Age-Years</u>	<u>Yield (Cords)</u>	<u>Assessed Value</u>	<u>Annual Tax For Period</u>	<u>Total Accumulation of taxes @ 4%</u>
20			\$ 0.10	
30	3.6	\$ 7.20	.072	\$1.21
40	17.4	34.80	.348	2.65
50	39.7	79.40	.794	8.10
60	58.4	116.80	1.168	21.52
70	69.7	139.40	1.394	49.40
80	76.6	153.20		

Site 50

20			\$ 0.10	
30	2.2	\$ 4.40	0.044	\$1.21
40	11.7	23.40	.234	2.32
50	29.1	58.20	.582	6.24
60	44.2	88.40	.884	16.19
70	54.2	108.40	1.084	34.57
80	60.0	120.00		

Site 40

20			\$ 0.10	
30	0.9	\$ 1.80	0.018	\$1.21
40	6.3	12.60	.126	2.03
50	17.6	35.20	.352	4.51
60	28.9	57.80	.578	10.90
70	36.5	73.00	.73	22.07
80	41.3	82.60	.826	

Planting:

Whether in a mixed or in pure forests, spruce and balsam possess two qualities that enable them to maintain a uniform proportion in naturally reproduced stands. These are the ability to withstand shade from overtopping trees, and the remarkable power of reproduction of these species. Except on lands which run heavily to hardwoods, natural reproduction of spruce and balsam presents no problem. Before cutting of the mature stand is undertaken, sufficient reproduction must be present. If planting costs of 12 to 15 dollars per acre are to be incurred in planting, the management

of forest lands should become a public charge; private business enterprise cannot carry the charges for a long period of years. In the spruce belt, however, in which the Northeastern pulp and paper industry is mainly interested, only minor costs need be incurred to assure full restocking of bare land. Protection of lands from fire and adequate brush disposal will, in general, prove to be the only measures necessary to permit young growth to establish itself naturally on spruce lands.

For the purposes of calculations to show costs of forestry, a planting reserve of \$3 per acre is set aside to meet contingencies. Interest on the planting investment at 3 per cent compounded annually will amount to the totals shown in the following table:

Interest on Planting Investment

(Per Acre at various rotational ages)

Formula -  $\$3(1.04^n) - 3$

<u>Age-Years</u>	<u>Total</u>
30	\$ 9.73
40	11.40
50	18.32
60	28.56
70	43.71
80	66.15

Cultural Costs - Weeding and Girdling

Nearly all the so-called "pure" spruce stands contain an admixture of hardwoods to a varying degree. This hardwood growth is a disturbing factor in the problem of reproducing the spruce-fir types. While the problem is easily met in the spruce flat type, it presents considerable difficulty in the spruce-slope and spruce hardwoods types.

Stands which have been clearcut may reproduce almost wholly to hardwoods even though a sufficient representation of spruce reproduction is present after cutting. Rapid germination or extensive sprouting and early height growth of hardwoods quickly results in suppression of the spruce

reproduction and generally clothe the area completely with hardwood stems within three years after the clear cutting.

Westveld advocates two simple and inexpensive methods of eliminating hardwoods, or at least reducing their representation in the composition of the stand. Where an overtopping stand of hardwoods are present over the spruce reproduction, girdling should be carried out. This operation should be restricted to areas where hardwoods have little potential market value or where the area will show a higher return after expenditures to obtain pulpwood growth. Selective girdling may be practiced in order to eliminate all but the best formed of the hardwoods which may be grown to sawlog size. The individual case must rule all such silvicultural practices, for the mill location, quality of the land, and the local lumber market situation should always determine the plan to be followed.

Westveld has found that girdling operations carried out in the Northeast cost from \$1 to \$2 per acre depending on the number and size of the hardwoods to be girdled.

Girdling of standing hardwoods may not prove to be wholly adequate, particularly on the stronger hardwood stands. Where spruce and fir reproduction is followed by vigorous sprouting of hardwoods, it is necessary in that event to cut back the hardwood sprouts, in general, 5 to 8 years after girdling and cutting. In already established stands which are past the reproduction stage, initial weeding operations for cleaning out the hardwoods may prove to be rather costly and in general unsatisfactory. Where possible, weeding should be carried out at an early stage before any suppression of the spruce has taken place.

Westveld finds that weeding costs on experimental areas in New Hampshire cost from \$2 to \$4 per acre depending on the intensity of the operation. For purposes of further calculations it will be assumed that weedings will be carried out in the fifth year after cutting at an average

cost of \$3 per acre.

The table following shows total cost of weeding operations at various ages carried at 4 per cent interest compounded annually.

Costs of Weeding - C \$2.00 per Acre - 4 Per Cent

<u>Age-Years</u>	<u>Dollars</u>
30	5.33
40	7.89
50	11.68
60	16.29
70	25.60
80	37.90

Total Costs of Forestry in the Spruce Region

Considerable investigative work by Westveld indicates that in advanced growth spruce and spruce-hardwood stands in the Northeast, girdling the hardwoods will materially increase the yield of spruce and fir. On such areas, however, the individual case will govern the plan to be followed. Studies should be made to determine whether expenditures on such cultural operations will sufficiently increase the final yield to prove financially justifiable.

In general, however, where spruce and spruce hardwood areas have been recently cut over, calculations can be carried out from existing data to indicate the economic rotational age and the costs of growing the stands. Based on previously shown figures, a series of soil rent figures are presented to indicate the age of highest soil rent.

$$\text{Formula} \quad Se = \frac{Yr^n - T^n - P(1.04^n) - W(1.04^{n-5}) - e}{1.04^n - 1} \cdot .0p$$

Yr.<sup>n</sup> --Yield in nth year - Hypothetical stumpage value = \$3 per cord.

T<sup>n</sup> --Taxes in nth year.

P --Planting reserve.

W --Weeding cost in nth year.

Interest at 4% compounded annually.

c = annual protection expense = 10¢ per acre per yr.

Soil Rent Values

<u>Age-Years</u>	<u>Site Index</u>			
	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
30		Negative	Negative	Negative
40	Negative	Negative	\$ 1.37	\$ 5.50
50	Negative	\$ 0.50	6.15	9.00
60	Negative	0	5.50	7.80
70	Negative	Negative	2.45	3.70
80	Negative	Negative	Negative	Negative

---

Examination of the above table indicates that under a pulpwood yield and series of costs as shown previously, the highest economic use of the soil will be realized in operating on a rotation of 50 years. With bare land worth about \$3 per acre, no expenditures should be incurred on sites 30 or 40.

The soil rent values shown do not indicate what an acre of land should sell for, but point out the capital value of the land if the above expenditures are incurred to realize the attendant yields.

One strong point brought out is that forestry applied to the poor sites is a poor investment. Such areas as spruce swamps and poor spruce flats should be cut and abandoned where possible. No figures are shown for site class 70 as such areas are comparatively rare.

**Stumpage - Cost per Cord under Forest Practice:**

The illustration shown on the next page applies to the Medium spruce site class found in the Northeast - site index 50.



Data - Rotation 50 years

Yield @ 50 years = 30 cords

Costs

Interest on land investment

$$\$3(1.04^{50}) - \$3 = \$18.32$$

Taxes 6.24

Costs of protection

$$\frac{.10(1.04^{50}-1)}{.04} 15.26$$

Cost of Weeding 11.68

Planting reserve 18.32

Total \$69.82

Cost of stumpage (merchantable) \$2.33 per cord.

Area Necessary

To supply a 100 ton sulphite pulp mill in the Northeast, if average site spruce lands are available:

60,000 cords per year needed.

30 cords per acre = 2,000 acres cut annually.

2,000 acres x 50 years = 100,000 acres.

100,000 acres total area.

Hypothetical Calculation of Distance Factor

The governing factors as to whether a company owned pulpwood unit is feasible or not are: (1) whether a sufficient area of economically suitable land is available, and (2) whether such area is available within a financially justifiable distance of the mill.

The following illustration shows a method of mathematically determining the range within which a pulpwood unit should be built up. Since such calculations are necessarily based on present transportation costs, the resulting estimate will be a conservative one as such costs show a steadily decreasing trend with progressively increasing efficiency of equipment.

Suppose the mill determines its pulpwood cut on its own lands should cost \$10 delivered at the mill.

Stumpage Cost - \$2.33 per cord.

Present transportation cost - \$0.05 per cord per mile.

Cutting, bucking, yarding, skidding - \$4.00 per cord.

Then:  $\$2.33 + \$4.00 + \$0.05 x = \$10$

where  $x$  = miles to outside limit of pulpwood unit.

$$\begin{aligned} .05 x &= 3.66 \\ &= 73 \text{ miles} \end{aligned}$$

In the above illustration the outer limit of the pulpwood unit should lie around 73 miles in any direction. Such calculation assumes a straight haul. Some allowance must be made for longer hauling distances due to winding roads or other transportation facilities. If we assume the haul is  $\frac{1}{3}$  longer due to winding roads, the economic limit would be cut down to around 50 miles.

Conclusion:

We are all aware that the paper industry is nearing the end stages of a period of transition. Great regional changes have been in progress, and only now are we approaching a state of competitive balance. Within a decade the newsprint industry shifted to Canada, the wrapping paper industry moved southward, and a great sulphite industry has grown up on the Pacific Coast. The new and the old meet in common markets and have resulted in marked changes in the industrial set-up and in the kinds of paper produced in the old regions. The geographical shifts have, however, been so rapid that regions which were the main sources of production less than two decades ago, are today tending to be marginal in many paper grades.

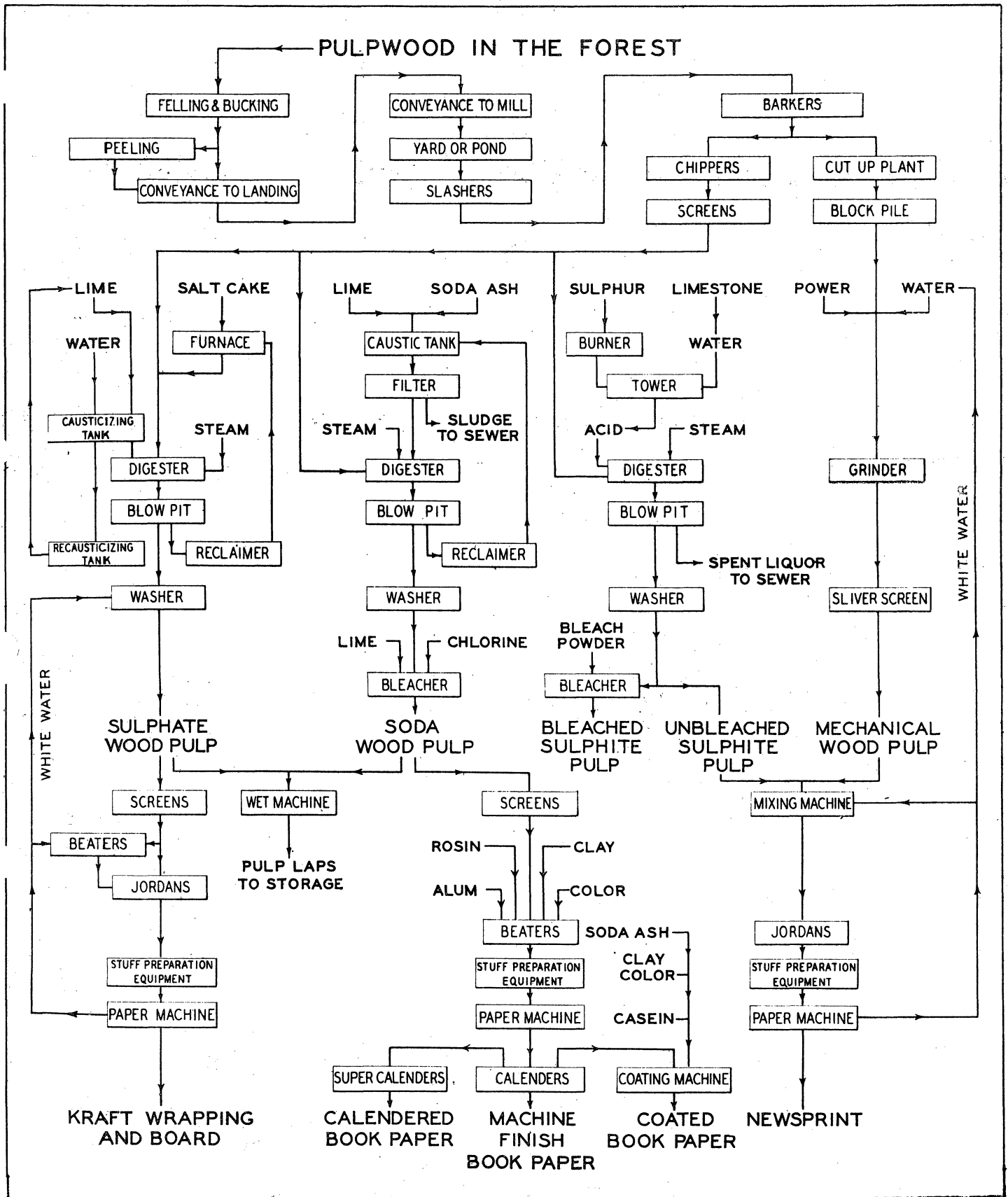
High wood costs in the older regions have increased costs of production, but fortunately for these regions, they have been able to purchase pulp at costs low enough to grant the older industry a favorable competitive position.

While the continual shifting of northeastern paper production is in the direction of higher grades, wood remains the most important raw material for paper. The fact that this development reduces the importance of wood costs in the total cost of paper does not preclude the necessity of assuring a steady, and more or less certain supply of the material. So far as the industry itself is concerned, it is of small moment where the wood is grown -- whether it is domestic or foreign. In that case it must be recognized that wood grown within the region must of necessity compete with Canadian and other wood, and as previously pointed out, with purchased pulp.

Figures shown in the text are rather conclusive, however, that pulpwood can be profitably grown on the better site classes, and in fact will prove increasingly profitable as regional costs shift towards a balance

commensurate with the value of the product produced and the intensity of use. Under such conditions it is a bold (and perhaps rather foolish) individual who would attempt to relate costs of forestry to forest utilization.

I let the matter rest at this point -- let each person interested draw his own conclusions as to the industry's future trends.



**MATERIALS AND EQUIPMENT USED IN THE MANUFACTURE OF TYPICAL WOOD PULPS AND PAPERS**  
 This diagrammatic chart does not represent a typical mill layout; it is, rather, a composite of several types of manufacture.

## APPENDIX A

### Pulping Process

Wood pulping processes come under two major heads: mechanical and chemical. The mechanical or groundwood process involves grinding the wood on revolving stones in the presence of large quantities of water. The resulting pulp contains all the original substances of the wood, except certain extraneous water-soluble materials. The yield of pulp per unit of wood is therefore high -- about one ton of pulp per cord of wood. The yield, however, varies to a great extent with the species of wood used, and with inherent difference in the same species coming from different localities.

Mechanical pulp is produced chiefly from spruce, balsam, and hemlock, and to a lesser extent from aspen, cottonwood, white birch and jack pine. The pulp contains all the lignin complex present in the original wood substance -- about 30 per cent, air-dry weight. The lignin is the chief degrading material in groundwood, being relatively unstable chemically, oxidizing and discoloring readily in the presence of air. Groundwood papers are therefore used mainly for such purposes as newsprint, where low cost rather than long-life is essential. In the case of newsprint, about 20 per cent unbleached sulphite pulp is added to the groundwood to strengthen the product. Other papers in which groundwood is used are hanging papers, catalogue, tissue, low grade book and writing, magazine, and novel news.

With the exception of a later discussed process, the other processes are purely chemical. They are the sulphite, the sulphate, and the soda -- deriving their names from the chemical liquors used.

These chemical processes separate the wood fibres by digesting the cementing layer between them. It is highly probable that the cementing layer (the middle lamella) is lignic in character; its removal is therefore partially responsible for the higher grade of wood pulp obtainable by the chemical processes. The fibre structure itself is made up chiefly of cellulose and lignin, the latter material as well as extraneous fats and oils being removed to varying degrees in the course of cooking with the chemical liquors. Control over the purity of the pulp is obtained by varying the cooking time, the pressure, or the concentration of chemicals. The chief residual material (or only residual material in the case of highly purified alpha pulps) is cellulose; a highly stable carbohydrate in fibre form which lends itself well to the manufacture of the better grades of paper. This latter generalization must, however, be limited -- since the exact chemical process and the species of wood used have a direct bearing on the grade of the final paper product.

The soda process is the oldest of the three chemical processes. The chemical reagent used is a solution of caustic soda. The basic reaction involves a neutralization of the acid portions of the wood to yield the pure fibres. This process is confined to the reduction of short fibered, white colored hardwoods, such as aspen, basswood, beech, birch, maple, and several others. The resulting pulp is composed of short, soft fibres which are highly desirable as fillers (when mixed with other pulps) for the better grades of book and magazine papers. Practically all soda pulp is bleached at the producing mill. The yield runs about 38 to 40 per cent of the weight of the wood used.

In the sulphite process, which is the most widely used at present, the chipped wood is cooked in a solution of bisulphite of lime (prepared at the pulp mill). Depending upon the use to which the pulp

is to be put, the process may be controlled to yield a large proportion of lignin and other non-cellulosic materials, or to yield the cellulose alone to any degree of purity. Sulphite is the most versatile of the pulps. It may be mixed with other wood pulps, rags, or other vegetable fibre to produce almost any type of paper product. Highly purified it is similar in chemical composition to cotton fibres and can be used for many of that material's purposes. Unbleached sulphite is used in newsprint and other cheap printing paper, paperboard and linings, wrapping, tissues, and other papers in which pure whiteness is not essential. Bleached sulphite is used in high-grade printing, writing, white wrapping and other higher grade papers. Highly purified grades of sulphite are used for cellulose compounds and rayon.

Sulphate pulp or kraft pulp is made by a process which has been modified from the soda. Sodium sulphate (salt cake) is used in the preparation of the cooking liquor -- the final liquor being a solution of sodium hydroxide and sodium sulphide. This process is adapted to pulping most species of wood, including resinous coniferous species for which the sulphite cannot be employed. The treatment is less vigorous than that of the sulphite and the resulting pulp is of high strength. Much of the non-cellulose materials are left, the cooking lasting just long enough to separate the fibres. The yield runs 45 to 48 per cent of the wood substance.

The nature of the process and the dark color of the wood used yields a pulp which is brown in color and difficult to bleach. Only a small part of the total sulphate is bleached since no method has yet been perfected that will whiten the pulp without sacrifice of strength and permanence qualities. Unbleached sulphite is used chiefly for wrapping and bag papers in which strength is the main consideration. Other major uses are for paperboard, liners, and towels.



Another variety of the mechanical process, as developed by the Forest Products Laboratory, is the so-called semi-chemical process. It differs from the pure mechanical in that the wood is partially digested in dilute chemicals before grinding. High yields and great promise have been reported of this process, though it has not come into extensive use. Its main advantages are higher yields than by the ordinary mechanical, the choice of a wider range of woods, and economy of manufacture. At the present time this process is used chiefly for pulping chestnut chips after the extraction of tannin from the wood has been carried out.

## APPENDIX B

### Utilization of Hardwoods for Pulp and Paper

With the constant search for new softwood pulping species, the Northeast and Lake States seem inclined to overlook a great potential pulpwood supply at their very doors. That potential supply is the hardwood forests -- long regarded as unsuitable (except for soft bulky pulps) to the needs of the industry. Curran attributes this attitude largely to prejudice not based upon sound scientific reasons. (66)

The pulping of most hardwoods by the mechanical process, with no previous chemical treatment, is definitely limited by the excess power requirements for grinding. Research by the Forest Products Laboratory, as well as by numerous private agencies, has shown, however, that with only minor modifications in the present chemical processes, hardwoods may be utilized for many high grade paper products. In chemical composition both hardwoods and softwoods are similar. Table 7, compiled from tests made by the Brown Company, indicates the composition of hardwoods and other cellulosic materials used for paper-making.

As Campbell (63) has stated "the essential constituent of all paper-making pulps is cellulose, and it is to cellulose that we must look for the properties which enable us to make paper." Hardwood pulps run only about one per cent less in total cellulose content -- a deficiency which is more than made up by the greater pentosan content of hardwoods. While pentosans are not directly a paper-making material, they contribute an advantageous modifying influence -- adding weight and bulk to the product and increasing the pulp yield per unit of wood.

TABLE 7. CELLULOSE CONTENT AND RELATIVE CONTENTS  
OF VARIOUS PULP AND PAPER MATERIALS

	W O O D			C O T T O N S	
	Softwood Sitka Spruce	Hardwood	Coniferous Groundwood	Absorbent Cotton	Rag Stock New White
Total Cellulose (by Cl <sub>2</sub> )	56.8	55.9	55.0	100	
% of total alpha cellulose beta			94.1 2.96	99.7 0.5	94.85 2.68
Fibre Length			0.6mm		
Copper Number			4.06	0.58	1.08
Lignin	28.5	27.0	29.8	0.33	0.33
Pentosans			7.7	0.69	0.52
Viscosity (Cuprammonium)	7.0	22.6	Insol.	680 sec.	5.30

	Unbleached Pulps			Bleached Pulps		
	Softwood Sulphite	Hardwood Sulphite	Softwood Sulphate	Softwood Sulphite	Hardwood Sulphite	Hardwood Soda
Total Cellulose (by Cl <sub>2</sub> )	93.65	91.94	93.0	99.8	99.32	98.73
% of total alpha cellulose beta	87.62 2.64	86.52 4.66	91.7 0.50	84.8 7.48	83.39 10.66	81.47 15.84
Fibre Length	0.67	0.42	0.64	0.6-0.7	0.32	0.44
Copper Number	2.90	3.10	1.16	3.42	3.08	2.62
Lignin	3.23	3.34	4.8	1.24	2.16	1.16
Pentosans	4.29	8.34	7.92	4.18	9.3	11.68
Viscosity (Cuprammonium)	14.50	17.28	27.0	3.0	3.0	0.6

The chief objection to hardwoods has always been concerned with the shortness of the fibres. Monsson at the 1928 meeting of the Technical Association of the Pulp and Paper Industry tended to discount this objection and in brief, brought out the following points:

1. That aspen, maple, birch, and black gum can be readily pulped by the sulphite process giving high yields of bleachable pulps, presumably suited for many grades of paper and paperboard in which softwood sulphite is now incorporated.

2. That the cooking curves suitable for softwoods were equally suitable for hardwoods, but that a somewhat higher free acid was necessary and the period of impregnation required lengthening in order to insure a thorough penetration of the chips.

3. That the cooking curves were so nearly identical with those used for spruce and hemlock that it was possible to pulp these softwoods in mixture with hardwoods.

4. That the pulps from the hardwoods were of good color unbleached, and could be cooked to bleach easily and develop a fair degree of strength upon heating, although not quite the equivalent of softwood sulphite in this respect, as far as our present knowledge of fibre processing goes.

In addition to the above, Curran<sup>(66)</sup> points out that hardwood sulphite combines certain desirable features of both sulphite and soda pulps. For these reasons hardwood sulphite shows attractive possibilities of replacing soda pulp as well as softwood sulphite for certain grades of bond, writing, cover, and printing papers.

According to available statistics of the Forest Service there are available in the United States 128,494 million cubic feet of hardwoods. This is exceeded by the softwood resource but the interesting part is that practically all of the hardwood stands are in the Northeastern States, the Lake and Central States, the South Atlantic States and the Mississippi Valley.

About half the total is in the Northeast and the Lake States. The cut-over areas of these latter regions are restocking to second-growth consisting largely of hardwoods. With proper forest management, utilization of these areas could begin almost at once and at the same time made to yield a sustained volume of pulpwood. The industry in the older regions has at its very door a supply which if it could be used, and combined with its softwood resource, would insure a pulpwood supply for all times to come.

American Paper and Pulp Association statistics for 1936 show hardwoods selling at an average of \$8.66 per cord as compared to \$10.91 per cord for domestic spruce, and \$12.66 per cord for imported spruce, all peeled and delivered at New England mills. As pulpwood is bought on a volume basis, hardwoods give a greater mill output per cord than do softwoods and on a true-value basis the former would show an even greater cost advantage. The great contribution of extensive utilization of hardwoods by the industry in the Northeast would, however, be in the simplification of the region's forest management problems. The growing of pure stands of spruce on natural hardwood-conifer sites is as costly as well as silviculturally risky procedure. With an extensive utilization of hardwoods, a more or less natural composition of the managed forest area, favoring spruce to a great extent, would be easy to attain. No planting costs would be incurred, silvicultural costs would be low, high volume thinnings would be available, and the fire hazard would be at a minimum. Rather than the even-aged management necessary in growing pure stands of spruce, all-aged management could be practiced -- permanent road systems installed, and probably a minimum of necessary costs would be involved.

The possibilities are, in general, very attractive, and with closer cooperation between the pulp and paper chemist and the forester, the future may see an extensive utilization of hardwoods in the older regions and a new competitive balance established.

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